119502

THE ENGINEERING MAGAZINE

AN INDUSTRIAL REVIEW

VOLUME XXIV

October, 1902, to March, 1903

NEW YORK

THE ENGINEERING MAGAZINE

1903

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By JOHN R. DUNLAP

THE ENGINEERING MAGAZINE

THE WORLD IS ITS FIELD

VOL. XXIV. OCTOBER, 1902. NO. 1.

THE FOUNDATIONS OF THE AMERICAN IRON INDUSTRY.

By Archer Brown.

The whole of modern engineering is dependent on iron and steel—directly, on the constructional side, and indirectly this involves the whole. The enormous expansion of engineering industries during the past decade has been paralleled by a nearly proportionate expansion in the production of iron; but with the tendency of demand represented by a rapidly rising curve, anxious questions naturally present themselves as to the future of supplies. To the general answer of these questions Mr. Brown brings a remarkably comprehensive practical knowledge of the American iron-trade—especially the initial sources of supply, the conditions of successful iron production, and current or coming events in the iron and steel industry. His review is so well-based, therefore, as well as so ably and admirably presented, that it is of the utmost importance. Certain references to politico-economic conditions which seem to the editors to merit fuller comment than is appropriate to an introductory paragraph are treated further on page 105.—THE EDITORS.

THE development of the iron industry of the United States has been marked with surprises. From complete dependence upon the old world the country has leaped to a pre-eminence so complete that even its rivals believe and tremble. In the great railroad-building period of 1870-72 England furnished the rails and other materials at prices two to three times above those which are now deemed abnormally high. Then England produced three times as much iron and steel as the United States. Since then Germany has challenged the supremacy of Great Britain, and passed her in a decade of remarkable growth. And yet, in the current year of 1902, the United States of America will produce more iron than England and Germany combined. Indeed, there is a margin of excess to spare about equal to the product of France. If we add to this statement another fact, viz., that even this vast production is not sufficient for home require-

ments, and that the United States is today, in spite of a stiff tariff, the best customer in iron and steel that Europe has, credulity is taxed to the limit.

This unparalleled growth has not been without its backsets. The ups and downs of the trade have been so marked as to call from its chief prophet the expression that iron is either a prince or a pauper. Indeed the vicissitudes have been so great, and the ill-starred enterprises so numerous, that capital has always had a peculiar dread of it, and conservative investors have counted it a hazardous field. An industry so vast, so episodical, so filled with promise of still further greatness, and so closely linked with the whole fabric of national material progress, naturally comes in for a full measure of discussion.

What will be its future? Are the wonderful natural resources on which it is built inexhaustible? Is the support of a protective tariff longer needed or desirable? Can American manufacturers hope for a world trade and continue paying to labor double the rates paid by their rivals? Is the enormous home consumption a stable or a temporary factor? Will the consolidation of mines, furnaces, mills, and carrying lines, into great corporations with huge aggregations of capital, help or hinder the broad development of the industry? Can the facilities for the cheap assembling of raw materials, which are the wonder of other nations, be further improved? There is material in these and like inquiries for ample and interesting study.

It is first of all in the vast natural resources of the United States that the industry finds its sure foundation. The basis of all iron and steel making is reliable coking coal and iron ores suited to the Bessemer or the basic process of producing steel. The Connellsville district in Western Pennsylvania carries the largest known seam (9 feet) of high-grade coking coal. But the district is distinctly limited, and at present rate of mining, will be exhausted within a generation. Nature, however, was lavish in providing reserves. The developments of the past ten years among the vast bituminous coal regions of West Virginia, southwestern Virginia, southeastern Kentucky, and eastern Tennessee, have revealed deposits of high-grade coking coal that would seem to be ample to supply the blast furnaces of the world for centuries to come. It is only a question of building railroads, opening mines, and constructing coke ovens. The far-sighted action of the United States Steel Corporation in acquiring and developing a great tract of this coal in the Pocahontas field in order to conserve its Connellsville supply is the most important step yet taken in shifting the base of fuel supply.

Not all good bituminous coal will make coke. Indeed, in all the great coal fields of Ohio, Indiana, Illinois, Missouri, and important coal sections of Tennessee and Kentucky, there has not been found an acre of coking coal. Draw a circle around the Connellsville section in Pennsylvania including the so called "Mountain" operations adjacent on the east; another around the section where Virginia, West Virginia, Kentucky, and Tennessee meet; another around the Warrior coal field in Alabama, and a fourth around a newly developed district in Colorado and Utah, and you have all the known sources of fuel supply for iron and steel making in the United States. It is true that anthracite coal is still used in connection with coke, in the blast furnaces of eastern Pennsylvania, but it is a small and diminishing factor. The circles above indicated, however, embrace deposits so reliable and so extensive that a rate of consumption many times greater than the present could go on for generations without raising the first question of exhaustion.

Though the growth of coke production has been very rapid in the past few years, it has not kept pace with the demand, and the remarkable year of 1902 has witnessed the banking of furnaces for days and weeks because of short fuel supply. As late as 1880 the total coke production was only 3,338,300 tons. In 1890 it had grown to 11,508,021 tons, and in 1901 it reached 21,795,883 tons, of which probably 85 per cent. was used in the smelting of iron ores. Of this total, Pennsylvania produced two-thirds, West Virginia a tenth, and Alabama, Virginia, and Colorado the remainder. The government records show the cost to have been $1.28 per ton in Pennsylvania, $1.88 in Alabama, $1.15 in Colorado, and $1.11 in West Virginia. No other coke in the world approximates the cheapness of cost of the great producing centers in Pennsylvania and West Virginia.

Turning to the other bases of iron and steel manufacture—abundant, suitable, and cheap ores—the foundation seems to be equally secure. There is iron ore in thirty-one states of the Union. Very many of the deposits, however, are unavailable for one or another cause. Thousands of owners of iron lands in Virginia, Tennessee, Alabama, and Georgia, in the south, and in Illinois, Ohio, Wisconsin, and even Pennsylvania, in the north, have had their dreams of wealth dispelled by finding that the ores were too lean, too high in phosphorus or titanic acid or some other injurious element, or were too expensive to mine profitably in competition with the cheaply won deposits in the Lake Superior districts or in the southern States. Even the first miners on the Messabi, the richest of all the upper lake ranges, abandoned their machinery and gave back their lands to the State because

the ores were too low in iron to stand long shipment. These pioneers were too far south and west.

There are practically but two processes of making steel in the United States—the Bessemer and the basic open hearth. The former is based on the low-phosphorus ores of the Lake Superior districts, and until the past five years, it had the right of way. More recently, however, the basic process has assumed importance, and its growth has been far more rapid than that of its older rival. Indeed, it may almost be said that Bessemer steel making reached its climax several years ago, and that the recent wonderful growth in steel making has all been in the basic form. This process has the advantage of using the higher-phosphorus ores that are found in many States. The standard specification of basic pig is phosphorus 1 per cent. or under; silicon 1 per cent. or under, and sulphur 0.05 or under, manganese between 0.50 and 2 per cent., the higher preferred. The basic bessemer or Thomas-Gilchrist process, generally used in Germany, and the Siemens-Martin, largely employed in England, have never found root in America.

The supply of low-phosphorus ores for making Bessemer steel was apparently nearer its limitations ten years ago than it is today. The so-called "old range" ores were being mined out at a rate that caused apprehension, and new discoveries were few. The opening of the Messabi district in Minnesota, however, in the decade from 1890 to 1900, changed the situation. The Messabi ores, usually running rich in metallic iron and very low in phosphorus, proved of almost unlimited extent as exploration work went on. Lying near the surface, in great beds from which the earth was easily stripped off, open mining with steam shovels was possible, bringing cost to the lowest point ever reached in the world. Hundreds of thousands of tons have been put on cars at 25 to 30 cents a ton. In Alabama, where the next cheapest mining is done on a large scale, the average cost of putting the red ores on cars is probably 60 cents a ton. But the Alabama ore carries less than 40 per cent. iron, against the Messabi 60 to 65 per cent. These rich beds could be only partially utilized at first, because of the extremely fine or powder-like condition of the ores making it difficult to prevent the strong blast of the furnace from forcing them through the flues or out of the top. Engineering skill, however, has largely overcome this difficulty, and by mixing a small percentage of the old range ores, good results are reached. It might be remarked in passing, that it is in the almost complete ownership of these old range Bessemer ores, essential for mixing, that the United States Steel Cor-

poration comes nearest to control of the situation. Independent Bessemer and non-Bessemer Messabi ores are abundant, and blast furnaces, mill, and lake carrying facilities can be created by the employment of capital. But unless new and extensive deposits of coarse or lump Bessemer ore are found, the grasp of the big corporation on the situation will be a powerful one.

The duration of the supply of Lake Superior ores can only be conjectured. Since the great revival in iron in 1899, exploration work has been carried forward with great energy, and it can safely be said that new sources of supply are opened faster than old ones are worked out. Close to 25,000,000 tons per annum, however, are now being brought down the lakes and this colossal tonnage can not be taken from the ground each year without leaving some tremendous gaps, which nature at present is not engaged in supplying. Some new and considerable deposits have been found in Canada, and the north shore of Lake Superior is known to be rich in iron, although so far as developed, sulphur is found to be present in troublesome quantities. On the whole, it may be said with reasonable certainty that the successors of this generation will not have to curtail their output of Bessemer steel because of exhaustion of the ore supply.

Basic open-hearth steel making would seem to be secure for all time on account of the wide range of ores which can be utilized. The non-Bessemer Lake Superior ores are now most extensively used; next come the high manganiferous ores of Virginia, and lastly the cheaply mined red ores of the Birmingham district in Alabama. In the latter section there has not been the rapid development of basic steel making that has been expected, owing to a variety of causes. In the building of the past two years, the greatest expansion in open-hearth plants has been in eastern Pennsylvania and the central western States. The magnetite and hematite deposits of New Jersey, partially neglected a few years ago, are found to be peculiarly adapted to the making of high-grade steel, and a new and important future is opened for these properties. It is not generally known, perhaps, that one of the largest and most costly blast-furnace plants yet constructed in the United States has gone into operation within a year in New Jersey, within two-hours' ride of New York, and in a district supposed to have been abandoned as an iron-making center.

Before leaving the subject of iron ores, it may be mentioned that very extensive deposits have been explored in sections of the country too remote from the great manufacturing centers to be available for commerce for many years to come. Wyoming, Utah, Washington,

and even California, have mountains of high-grade ores, needing only railroads, furnaces, mills, foundries, and an adequate market for the products. All of these will come in time. Texas also has its rich beds of both Bessemer and non-Bessemer ores, but the absence of coking coal and the remoteness of consuming centers will make the development slow. Mexico likewise is rich in ores, but so poor in fuel that for a long time to come the United States and other countries will have to supply the finished iron needed by the sister republic.

The most important deposits of iron ore outside the limits of the United States, which may either be drawn upon for supplying American furnaces or may appear in finished form to compete with the United States, are in Nova Scotia, Cuba, Venezuela, and Spain. Porto Rico, within the political borders of the United States, also has extensive Bessemer deposits. The extensive works lately completed at Cape Breton are now sending about a thousand tons a day to eastern American seaports, about equally divided in form between pig iron and steel billets. The Cuban ores have been used for twenty years as an important source of supply for the leading eastern steel works, but the quantity has increased but little, although energy and capital have been expended liberally in developing what seemed promising properties. The much-talked-of ores of Venezuela are no farther developed than they were at the time of Cleveland's well-remembered proclamation.

The tariff long ago ceased to be a question of vital import to the American iron industry. It needs no argument to prove that, but for the protection afforded by the tariff in the two or three decades following the war, the development of the great resources of the country would have been retarded indefinitely, to the immense advantage of England and Germany. But that period has passed. The infant is a giant. Does it follow that the tariff wall should now be taken down or lowered? The answer varies greatly, according to the point of view, or the school of economic belief of the individual. It is probably within the bounds to say that the attitude of most manufacturers is one of indifference, except as tariff changes might injuriously affect the general business situation, now prosperous to a degree never before witnessed in the United States or any other country. A defender of the protection system has only to point to the unexampled activity of the United States, while her great free trade rival is languishing in business depression, to give his answer. The average manufacturer, untrammeled with theories, and seeking only further extension and greater profits in his own business, and with a vivid recollection of the paralyzing effects upon trade of efforts at tariff revision in the past,

says "let well enough alone." The student sees inequalities and inconsistencies that call loudly for correction. The alarmist discovers giant trusts fattening upon the protection given them at the public expense. The western farmer would like to get his barbed wire lower. The railroad president wants to buy his steel rails on the prices afforded by English and German labor. The eastern merchant or structural mill could often buy its billets from abroad cheaper than at home, but for the tariff. The great implement and tool manufacturers of the west, with expanding export trade, want reciprocal arrangements with France and other Continental countries, and are justly bitter towards the small and highly protected industries of cheap jewelry, knit goods, and the like in the eastern States which have succeeded in blocking the reciprocity treaties in the Senate. And so on through the category of varying and conflicting interests.

It is safe to say that the "let well enough alone" policy will prevail, at least while the present prodigious prosperity lasts. The interests that complain are themselves making money so fast that it is hard to work up to the earnestness aand zeal of reformers, and the general public is too busy to lend its ear. The owners of mines and furnaces and mills might reply to the railroad president and the farmer that it is largely because of this great activity in iron and steel that the railroads have a traffic beyond their capacity to handle, and the farmers realize highest prices for great crops and wax rich. They could with justice also add that it will take more than one year of large profits to make up for the years following panic, tariff agitation, and currency discussions, when plants were idle and losses wiped out capital.

As to the prospect for a world trade in American iron and steel products, it must be admitted that two years have wrought a great change, and not in the direction of progress. In 1899 and 1900 American exports of rails, billets, wire, ship plates, and even of pig iron, were on a scale that struck terror to European makers. The United States carried its products to the very centers of production in Great Britain and Germany, underselling them at their doors. Now it is sending abroad nothing but agricultural machinery, machine tools, and sundry highly finished specialties in which American skill finds particular expression. English and German makers have no sooner pulled themselves together and reduced costs to meet the dreaded American competition, than America has withdrawn from the field. Not only that, but she has astonished them by becoming their largest and best customer, permitting them to ride over the tariff wall with three to five shiploads a day of pig iron, billets, structural shapes, plates,

etc. What has made this great change? The revival of trade and industry at home. At the height of phenomenal exports, home consumption was still 95 per cent. of the American make. Now it is 105 per cent. The home market is, after all, the overshadowing issue. The United States will deal again with the trade of the world when production once more exceeds consumption. That will not come as soon as anxious rivals on the other side fear, or ultra conservatives at home predict, but it will come. Meantime the depression in England and Continental countries has lowered wages and raw materials, while opposite conditions have heightened the factors of cost in America. Fundamental changes therefore must come before America regains the lost ground on foreign soil.

It is too early yet to measure with any degree of accuracy the influence of the great consolidations upon the future of the American iron and steel industry. Two or three things, however, seem pretty clearly established—and these are contrary to popular notion. The first is that, in the larger lines, there is not, and can not be, any monopoly. Competition will be comparatively free. The smaller manufacturers will multiply. If the big consolidations flourish, they will fatten. Their supplies can not be shut off. They can use the saame materials and processes as their great rivals. Their management will be often of the same high order, for it will come from the men who have created and own their business. The small independent manaufacturer is seldom over-capitalized, seldom mortgaged, and with light fixed charges, he will have a flexibility in the day of trial which will in a large degree offset the powerful advantages possessed by his huge rival in the ownership of raw materials, carrying facilities, the greatest plants, and unlimited working capital. Consolidations will never eliminate competition in the United States.

Another result of the great consolidations, already sufficiently apparent, is the steadying effect upon values. The violent fluctuations of the past, with their disastrous consequences upon all forms of industry, are not likely to recur. The action of the United States Steel Corporation in holding prices within bounds during the stress of excessive demand the past year has no doubt had an influence in prolonging the period of activity. Other makers have seen the wisdom of the policy and, to some extent, adopted it. The real test will come, of course, when demand slackens, and there is not business enough to go around. A conservative policy pursued then by leading makers will quickly adjust supply to demand. The radical one, which has usually been followed in the past, of filling the big mills with work without regard to

prices, would provoke a war which would of necessity be hardest on those with the greatest relative fixed charges and outstanding securities. It is safe to assume that, with power centered in fewer and stronger hands than ever before, better counsels would prevail.

There is no more popular belief with respect to the trusts than that they are able to force a higher level of prices at home by selling their surplus abroad at greatly reduced prices. Every man connected with the manufacture of iron and steel knows how complete is this fallacy so far as his own products are concerned. As a matter of fact, for years past the makers of American machinery and other products of iron and steel have, in times of depression at home, realized their best prices in the export business. The moment home demand has become more profitable than the foreign, the latter has been dropped. In the nature of things it can not well be otherwise while competition remains free. The Germans are able to pursue such a policy to their obvious advantage, because their iron and steel industries are held as it were in one hand through the operation of close syndicates. In America, there is no monopoly and not even an attempt at control.

The question, so often raised, as to how long the present period of great activity and high prices can last will be answered by different authorities very much according to mental habit and temperament. The conservative reasons from past experience that booms are short-lived; that we have usually had five years of declining to two years of advancing prices; that we must before long pay the penalty of the great increase of production witnessed the past three years; that over-capitalization of companies and speculative trading can have but one end, etc. The man of optimistic views sees before us a period of national development, and of material progress throughout the world, compared with which even the great achievements of the past are tame. He reasons that iron and steel lie at the very foundation of such progress, and that it is the destiny of the United States to furnish a steadily increasing proportion of the world's requirements. He thinks the past five years, with its creation of wealth, its payments of debts, its settlement of financial questions, its uplift in the spirit and ambition of the people, has brought in a new era, and that it is narrow and fallacious to try to square the conditions of today with those which prevailed in the years of panic and turmoil. Space is wanting here to analyze these opposing views and try to reach conclusions. But it is worthy of mention that in like discussions and forecasts in the past forty years, no prophet has been bold or visionary enough to predict the results which have really come to pass in the growth of the iron and steel industry of this great country.

THE PHYSICAL LIMITS OF ELECTRIC-POWER TRANSMISSION.

By Alton D. Adams.

ELECTRICAL energy may be transmitted around the world if the line voltage is unlimited. This follows from the law that a given power may be transmitted to any distance with constant efficiency and a fixed weight of conductors, provided the voltage is increased directly with the distance.

The physical limits of electric-power transmission are thus fixed by the practicable voltage that may be employed. The effects of the voltage of transmission must be met in the apparatus at generating and receiving stations, on the one hand, and along the line on the other. In both situations experience is the main guide, and theory has little that is reliable to offer as to the limit beyond which the voltage will prove unworkable.

Electric generators are the points in a transmission system where the limit of practical voltage is first reached. In almost all high-voltage transmissions at the present day alternating generators are employed. Very few continuous-current dynamos with capacities in the hundreds of kilowatts and voltages above 4,000 have been built in Europe, and probably none in the United States. This is due to the troubles encountered at commutators when the effort is made to deliver energy at a greater rate and voltage than that just named. Where a transmission at high voltage is to be accomplished with continuous current, two or more dynamos are usually joined in series at the generating station, and a similar arrangement with motors is made at the receiving station, so that the desired voltage is available at the line though not present at any one machine.

Quite a number of such transmissions have been carried out in Europe with satisfactory results, and in one case a line pressure as high as 14,400 volts is in regular use, this being the voltage employed between Combe-Garat and La Chaux-de-Fonds, in Switzerland. Eight dynamos are connected in series to obtain the voltage named. For a transmission from the falls of Saint Maurice to Lausanne, Switzerland, ten dynamos in series are used, giving a maximum of 22,000 volts. Plants of this sort require very thorough insulation at each dyn-

amo, but this is fairly easy to obtain and there is no indication that the limit of practicable voltage has been reached, since higher voltage can be had by simply connecting more dynamos in series. In a system of this sort the frame of each dynamo is insulated from the earth in a very substantial manner, so as to limit the electric stress on the insulation between the windings and frame of any one dynamo to the voltage developed by it alone. Alternating dynamos that deliver current at about 6,000 volts have been in regular use for several years, in capacities of some hundreds of kilowatts each, and may readily be had of several thousand kilowatts capacity. But even 6,000 volts is not an economical pressure for transmissions over fifteen to fifty miles, such as are now quite common; consequently in such transmissions it has been the rule to employ alternators that operate at less than 3,000 volts, and to raise this voltage to the desired line pressure by step-up transformers at the generating station. More recently, however, the voltage of alternating generators has been pushed as high as 13,000 in the revolving-magnet type where all the armature windings are stationary. This voltage makes it practicable to dispense with the use of step-up transformers for transmissions up to or even beyond thirty miles in some cases. This voltage of 13,000 in the armature coils is attained only by constructions involving some difficulty because of the relatively large amount of room necessary for the insulating materials on coils that develop this pressure. The tendency of this construction is to give alternators unusually large dimensions per given capacity. It is quite clear, moreover, that the pressures developed in the armature coils of alternating generators must reach their higher limits at a point much below the 50,000 and 60,000 volts in actual use on present transmission lines. In the longest transmissions with alternating current there is, therefore, no prospect that step-up transformers at the generating stations and step-down transformers at receiving stations can be dispensed with. The highest voltage that may be received or delivered at these stations is simply the highest that it is practicable to develop by transformers.

A very high degree of insulation is much more easy to attain in transformers than in generator armatures, because the space that can be readily made available for insulating materials is far greater in the transformers, and further because their construction permits the complete immersion of their coils in petroleum. This oil is not only an excellent insulator but offers a much greater resistance than air to the passage of electric sparks, which tend to set up arcs between coils at very high voltages and thus destroy the insulation. Danger to insulation from the effect known as creeping between coils at widely

different pressures is largely avoided by immersion of the coils in oil. For several years groups of transformers have been worked regularly at 40,000 volts, notably those concerned in the transmission of power from Provo to the Mercur mills, Utah, over a distance of 35 miles. More recently transformers operating most of the time at 40,000 volts, but on one or two occasions at 60,000 volts for which they are ultimately intended, have been used in the transmission from the Colgate power house in Yuba County, California, to San Francisco, a distance by the line of 218 miles. Since the early months of the present year transformers have been operating at 50,000 volts at Cañon Ferry and Butte, Montana, for the purpose of an electrical transmission between these points, a distance of 70 miles. In none of these instances where transformers are working at 40,000 to 60,000 volts is there any indication that the upper limit of practicable voltage has been reached. On the contrary, transformers have repeatedly been worked experimentally up to and above 100,000 volts.

From all these facts, and others of similar import, it is fair to conclude that the physical limit to the voltages that it is practicable to obtain with transformers is much above the 50,000 or 60,000 volts now in practical use on transmission systems. So far as present practice is concerned, the limit to the use of high voltages must be sought beyond the transformers and outside of generating and receiving stations. As now constructed, the line is that part of the transmission system where a physical limit to the use of higher voltages will first be reached. The factors that tend most directly to this limit are two—temporary arcing between the several wires on a pole, and the less imposing but constant passage of energy from one wire to another. On lines of very high voltage arcing is occasionally set up by one of several causes. At a point where one or more of the insulators on which the wires are mounted become broken or defective, the current is apt to flow from one wire to another along a wet cross arm, until the wood grows carbonized and an arc is formed that ends by burning up the cross arm or even the pole. Where lines are exposed to heavy sea fog, the salt is in some cases depositd on the insulators and cross arms to an extent that starts an arc between the wires, and ends often in the destruction of the cross arm. One part of the 40,000-volt line between Provo and Mercur mills, Utah, runs near a former basin of Great Salt Lake, where the soil has much salt mixed with it. This salt is deposited with dust on the insulators and cross arms supporting the wires, and gives rise to arcs from wire to wire that consume energy at a rapid rate while they last, which is usually not more than a few seconds for a single arc. Occasionally a series of arcs from the

cause just named follow each other rapidly and become a very serious matter. The three wires of this line are arranged at the corners of a triangle about six feet apart, and the arcs started by deposits of salt often involve all three wires and flame up above them. Lines not subject to the action of salt fog or dust are much less liable to develop arcs, other conditions being the same. In some instances the glass and porcelain insulators supporting wires used with high voltages are punctured by sparks that pass right through the material of the insulator to the pin on which it is mounted, thus burning the pin and ultimately the cross arm. This trouble is easily met, however, by the adoption of a better grade of porcelain or of an insulator with a greater thickness of glass or porcelain between the wire and the supporting pin. Arcs between lines at high voltages usually start by sparks that jump from the lower edges of insulators, when they are wet or covered with salt deposit, to the cross arm. As the lower edges of insulators are only a few inches from their cross arms, the sparks find a path of comparatively low resistance by passing from insulator to cross arm and thence to the other insulator and wire. The wood of a wet cross arm is a far better conductor than the air. Where wires are several feet or more apart, sparks probably never jump directly through the air from one to the other. Large birds flying close to such wires, however, have in many instances started momentary arcs between them. The treatment of cross arms with oil or paraffine reduces the number of arcs that occur on a line of high voltage, but does not entirely do away with them.

As the voltages of long transmissions have gone up, the distance through the air between wires and the distances between the lower wet edges of insulators and the cross arms have been much increased. Most of the earlier transmission lines for high voltages were erected on insulators spaced from one to two feet apart. In contrast with this practice, the three wires of the transmission line put into operation at 50,000 volts between Cañon Ferry and Butte, a few months since, are arranged at the corners of a triangle 78 inches apart, one wire at the top of each pole and the other two at opposite ends of the cross arm. A voltage that would just start an arc along a wet cross arm between wires 18 inches apart would be quite powerless to do so over 78 inches of cross arm, the lower wet edges of insulators being equidistant from cross arms in the two cases. To reach the cross arm, the electric current passes down over the wet or dirty outside surface of the insulator to its lower edge. In the older types of insulators the lower wet edge often came within two inches of the cross arm. For the 50,000-volt line just mentioned the insulators are mounted

with their lower wet edges about eight inches above the cross arms. At its lower edge each insulator has a diameter of nine inches, and a small glass sleeve extends several inches below this edge and close to the wooden pin, to prevent sparking from the lower wet edge of the insulator to the pin. These increased distances between wires in a direct line through the air, and also the greater distances between the lower wet edges of insulators and their pins and cross arms, are proving fairly effective to prevent serious arcing under good climatic conditions, for the maximum pressures of 50,000 to 60,000 volts now in use. If these voltages are to be greatly exceeded it is practically certain that the distance between wires, and from the lower wet edges of insulators to the wood of poles or cross arms, must be still further increased to avoid destructive arcing.

The nearest approach to an absolute physical limit of voltage with present line construction is met in the constant passage of energy through the air from wire to wire of a circuit. A paper by Mr. Scott, Vol. XV, T. A. I. E. E., gives the tests made at Telluride, Colorado, to determine the rates at which energy is lost by passing through the air from one wire to another of the same circuit. The tests at Telluride were made with two-wire circuits strung on a pole line 11,720 feet in length. Measurements were made of the energy escaping from wire to wire at different voltages on the line, and also with the two wires at various distances apart. It was found that the loss of energy over the surfaces of insulators was very slight, and that the loss incident to the passage of energy directly through the air is the main one to be considered. This leakage through the air varies with the length of the line, as might be expected. Tests were made with pairs of wires running the entire length of the pole line and at distances of 15, 22, 35, and 52 inches apart respectively. Losses with wires 22 or 35 inches apart were intermediate to the losses when wires were 15 and 52 inches apart respectively. Results given in the original paper for the pair of wires that were 15 inches apart and for the pair that were 52 inches apart, are here reduced to approximate watts per mile of two-wire line. At 40,000 volts the loss between the two wires that were 15 inches apart was about 150 watts per mile, and between the two wires that were 52 inches apart the loss was 84 watts per mile. The two wires 15 inches apart showed a leakage of approximately 413 watts per mile when the voltage was up to 44,000 volts, but the wires 52 inches apart were subject to a leakage of only 94 watts per mile at the same voltage. At 47,300 volts, the highest pressure recorded for the two wires 15 inches apart, the leakage between them was about 1,215 watts per mile, while an equal voltage on

the two wires 52 inches apart caused a leakage of only 122 watts per mile or one-tenth of that between the wires that were 15 inches apart. When about 50,000 volts was reached on the two wires 52 inches apart, the leakage between them amounted to 140 watts per mile, but beyond this voltage the loss went up rapidly, and was 225 watts per mile at about 54,600 volts. For higher pressures the loss between these two wires was still more rapidly increased, and amounted to 1,368 watts per mile with about 59,300 volts, the highest number recorded. With a loss of about 1,215 watts per mile between the two wires 52 inches apart, the voltage on them was 58,800, in contrast with the 47,300 volts producing the same leakage on the two wires 15 inches apart.

Evidently, however, at even 52 inches between line wires the limit of high voltage is not far away. When the voltage on the 52-inch line was raised from 54,600 to 59,300, the leakage loss between the two wires increased about 1,143 watts per mile. If the leakage increases at least in like proportion, as seems probable, for still higher pressures, the loss between the two wires would amount to 6,321 watts per mile with 80,000 volts on the line. On a line 200 miles long this loss by leakage between the two wires would amount to 1,264,200 watts. Any such leakage as this obviously sets an absolute, physical limit to the voltage, and consequently the length, of transmission.

Fortunately for the future delivery of energy to great distances from its source, the means to avoid the limit just discussed, though novel, are not difficult. The electrical resistance of air, like that of any other subst ce, increases with the length of the circuit through it. The leakage de ibed is a flow of electrical energy through the air from one wire to another of the same circuit. To reduce this leakage it is simply necessary to give the path from wire to wire through the air greater electrical resistance by increasing its length, that is, by placing the wires at greater distances apart. The fact demonstrated at Telluride, that with 47,300 volts on each line the leakage per mile between the two wires 15 inches apart was ten times as great as the leakage between the two wires 52 inches apart, is full of meaning. Evidently, leakage through the air may be reduced to any desired extent by suitable increase of distance between the wires of the same circuit. But to carry this increase of distance between wires very far involves radical changes in line construction. Thus far it has been the uniform practice to carry the two or three wires of a transmission circuit on a single line of poles, and in many cases several such circuits are mounted on the same pole line. For the 70-mile transmission into Butte, Montana, only the three wires of a single circuit are mounted on one pole line, and this represents the best present practice. The

cross arms on this line are each 8 feet long, and one is attached to each pole. The poles are not less than 35 feet long and have 8-inch tops. One wire is mounted at the top of each pole, and the other two wires near the ends of the cross arm, so that the three wires are equidistant and 78 inches apart. By the use of still heavier poles the length of cross arms may be increased to 12 or 14 feet, for which their section should be not less than 4 by 6 inches. Placing one wire at the pole top, the 12-foot cross arm would permit the three wires of a circuit to be spaced about 10.5 feet apart. The cost of extra large poles goes up rapidly and there are alternative constructions that seem better suited to the case. Moreover, a few tens of thousands of volts above present practice would bring us again to a point where even 10.5 feet between wires would not prevent a prohibitive leakage. Two poles might be set 20 feet apart, with a cross piece between them, extending out 5 feet beyond each pole and having a total length of 30 feet. This would permit three wires to be mounted along the cross piece at points about 14 feet apart. Such a cross piece would approach a pole of moderate size in cost, and the distance between wires would soon reach its limit. Moreover, the support of wires carrying extremely high voltages above any horizontal arm is objectionable, because the lower wet edge of each insulator cannot be very far from such an arm, no matter how great the diameter of the insulator.

If the present transmission pressures of 50,000 to 60,000 volts are to be greatly exceeded, the best line structure seems to involve the use of a separate pole for each wire of a circuit, each wire to be mounted at the top of its pole. This construction calls for three lines of poles to carry the three wires of a three-phase transmission. Each of these poles may be of only moderate dimensions, say 30 feet long with 6- or 7-inch top. The cost of three of these poles will exceed by only a moderate percentage that of a 35- or 40-foot pole with an 8- to 10-inch top, such as would be necessary with 12-foot cross arms. The distance between these poles at right angles to the line may be anything desired, so that leakage from wire to wire through the air will be reduced to a trifling matter at any voltage. Extra long pins and insulators of the umbrella type at the pole tops will easily give a distance of two feet or more between the lower wet edge of each insulator and the wood of pin or pole. Such line construction would probably safely carry two or three times the maximum voltage of present practice, and would force the physical limit of electrical transmission back to the highest pressure at which transformers could be operated.

SALIENT FEATURES OF THE DÜSSELDORF EXPOSITION.

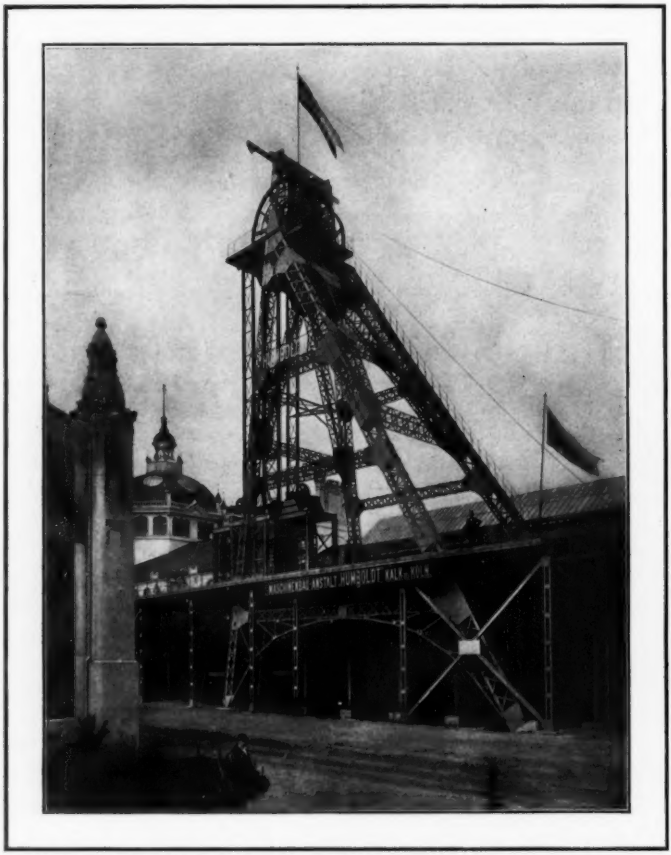
By Harrington Emerson.

The Düsseldorf Exposition has not attracted the attention it merits from English-speaking countries—partly, no doubt, through England's engrossment in the war and, later, in the coronation, and the United States' absorption in extraordinarily active home trade. This short review touches only the salient features of an exhibition which was highly illustrative of, and highly creditable to, the engineering industries and especially the iron and steel trade of Germany.—THE EDITORS.

ÜSSELDORF, on the right bank of the Rhine, a few miles below the more saintly Cologne, was at least a village nine hundred years ago and remained until this century little more than a pious residential village for countless princelings. It was furiously bombarded by the French in 1794, later became the capital of one of the Napoleonic duchies, succeeded to the benefits of the Code Napoleon, was given the rights of a free port in 1829, and even before that time became central and port city for the great coal and iron province of the German Empire, Rhenish Prussia, which is, on a very condensed scale, the Pittsburg-Buffalo-Cleveland region of Germany.

What iron and coal does for a region in concentration of population is shown here by a density of 500 inhabitants per square mile. This is one of the most densely populated regions of Europe, if cities alone are not counted. The neighboring fens of Hannover have a population of less than 40 to the mile. The dense population within a radius of ten miles is partly concentrated in four large cities—Düsseldorf, the port on the Rhine, a city with a history, with art galleries, and with a great polytechnic school; Barmen and Elberfeld, only five miles apart; and the city of Essen, which could more properly be called Kruppville, as the great Krupp establishment has on its payroll 43,000, of whom 25,000 are in Essen alone out of a total population of 117,000 in 1899. The history of the Krupps is an epitome of the growth of the whole province, and the firm's display is the most important part of the Düsseldorf exposition.

Just a generation ago, in 1880, Düsseldorf had a successful exposition, and the younger generation was desirous for another to show the city's advance. Then, too, there was disappointment over the



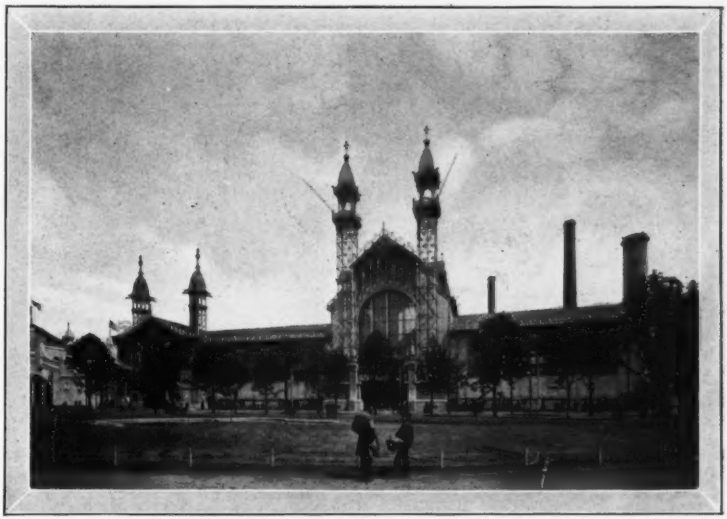
MINE HEADWORKS, ERECTED BY THE MASCHINENBAU ANSTALT HUMBOLT, KALK BEI KÖLN.

small space allotted to the iron industries of Rhenish Prussia and Westphalia at the Paris Exposition of 1900. The whole of Germany had none too large a space, and this was apportioned among the various parts of the empire.

Only recently Düsseldorf had won in a great struggle with the Rhine which was depositing on the inside of the bend opposite the city and encroaching on the outside of the water curve where Düsseldorf stands. This struggle had been going on for centuries, the Rhine having swallowed everything except the mediæval Thomas bastion,

and lower down the castle of the Dukes of Berg. The building of a harbor, finished in 1896, and the erection of the great Rhine bridge, begun the same year, gave an opportunity finally to conquer the river at a cost of over a million marks.

The right bank was filled in, and this inundated portion of the city and the swamp and meadow lands of the island Galzheim, in all a tract a mile and a quarter long, 800 feet wide, rising in terraces, was offered by the city for the exposition. To avoid the contingency of a June overflow, most of the buildings were placed thirty feet above low-water mark, the art gallery and machinery hall being thirty-five feet above. As the fine arts building was to be of stone and permanent, it became doubly necessary to place it on the highest ground. And alongside of it is the machine hall containing also enormously valuable exhibits impossible to move quickly.

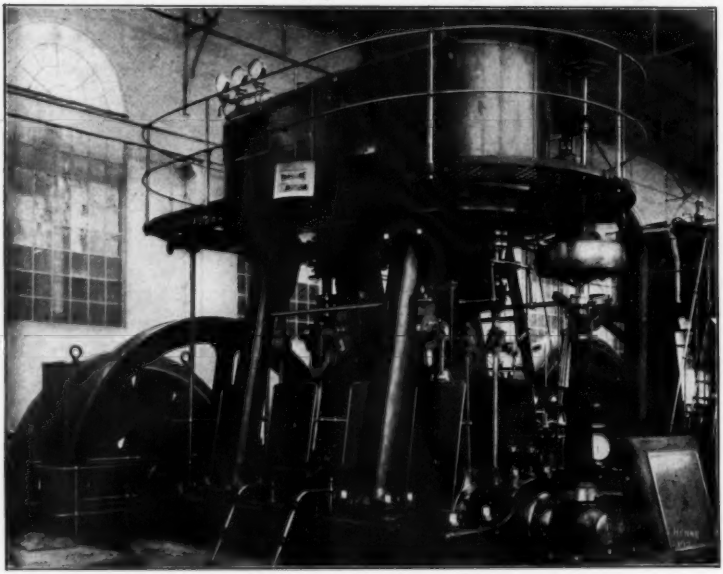


THE GUTEHOFFNUNGSHÜTTE COMPANY'S BUILDING AT DÜSSELDORF.
By courtesy of the Scientific American.

After it was resolved to hold an exposition, the large manufacturers took the lead, and it is typical of the slow changes in Germany that, instead of a young man, Mr. Ling, who had successfully directed the former exposition, was again placed in charge. The committee on plans met in July, 1900, and accepted the designs of the Hamburg architect, George Thielen, who did not live to see his work completed.

Under these plans, however, the cost of the main building was to reach 1,800,000 marks, but the frugal estimates had only provided for 900,000. By dint of rigid economies, suppressions, and curtailments, the lesser sum was made to do.

In two respects the Düsseldorf exposition has surpassed all its predecessors. It was ready on time, largely because the chief exhibitors were big firms who did not wait until the last minute, and it has been managed with extraordinary economy and financial ability. A sum of 520,000 marks was secured by private subscription, of which 300,000

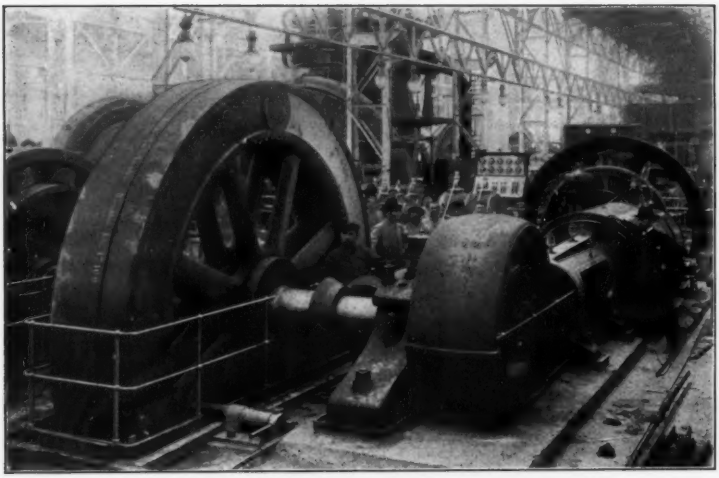


VERTICAL COMPOUND ENGINE BUILT BY K. & TH. MÖLLER, BRACKWEDE I. W.
330 horse-power, 120 revolutions.

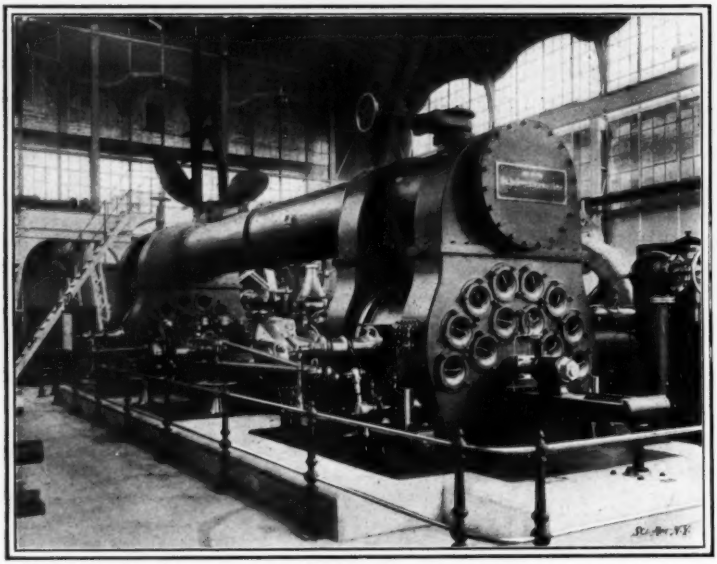
marks only was donated. The Düsseldorf citizens subscribed to a guarantee fund of 3,000,000 marks, the Rhenish Westphalia Coal Syndicate gave 100,000 marks, and the provincial governments of Rhenish Prussia and Westphalia guaranteed respectively 1,000,000 marks and 600,000 marks, of which nine-tenths was to be returned.

In general, the fiscal plan was to start with a small donation, to supplement this with what were in fact, if not in name, debenture loans, but in the main to expect the exposition to be self-supporting. The budget as finally arranged in 1900 was as follows, all sums being expressed in marks:

	Divisions	Receipts.	Expenses.
1	Subscriptions	608,450	124,000
2	Guarantees	147,550	170,000
3	Main Building	———	1,000,000
4	Machinery Hall	———	600,000
5	Fine Arts	345,000	1,045,000
6	Horticultural Hall	———	50,000
7	Parking and Flower Beds	———	80,000
8	Paths and Terraces	———	92,000
9	Rail Road	70,000	100,000
10	Restaurant Buildings	100,000	200,000
11	Water and Gas	3,000	100,000
12	Steam Boilers	———	50,000
13	Enclosures	15,000	35,000
14	Water Courses	———	30,000
15	Music Pavillions	———	12,000
16	Fences, etc.	———	85,000
17	Preparation of Site	———	10,000
18	Administration Buildings	———	20,000
19	Interior Decoration	5,000	80,000
20	Flags and External Decorations	———	50,000
21	Insurance Premiums	80,000	100,000
22	Space for Exhibitors	860,000	———
23	Restaurant Privileges	150,000	———
24	Wine and Lunch Counters	450,000	———
25	Commissions on Sales	50,000	———
26	Lottery	1,200,000	900,000
27	Entrance Receipts	2,300,000	5,000
28	Catalogs and Guides	75,000	30,000
29	Advertising	———	200,000
30	Exposition Newspapers, to opening	40,000	45,000
31	Exposition Newspapers During Exposition	40,000	———
32	Medals and Diplomas	———	25,000
33	Music, Fireworks, Sports	———	200,000
34	Electric Light and Power	150,000	350,000
35	Water and Gas Supply	5,000	50,000
36	Competition Plans	———	30,000
37	Committee on Care of Visitors	1,000	5,000
38	Prizes for Various Societies	———	5,000
39	Office and Entertainments	———	300,000
40	Postage	———	15,000
41	Rent of Offices	———	3,500
42	Inventory	5,000	30,000
43	Salaries and Uniforms of Attendants	———	100,000
44	Firemen, Police, Hygiene	———	60,000
45	Salaries of Administration	———	70,000
46	Agencies	———	20,000
47	Interest on Borrowed Money	———	75,000
48	Contingent Fund	———	148,500
		6,700,000	6,700,000



"UNION" TANDEM-COMPOUND ENGINE AND LAHMEYER DYNAMO.
500 horse-power, 94 revolutions.



GUTEHOFFNUNGSHÜTTE COMPANY'S EXHIBIT—1,000-HORSE-POWER BLAST-FURNACE-GAS ENGINE.
By courtesy of the Scientific American.

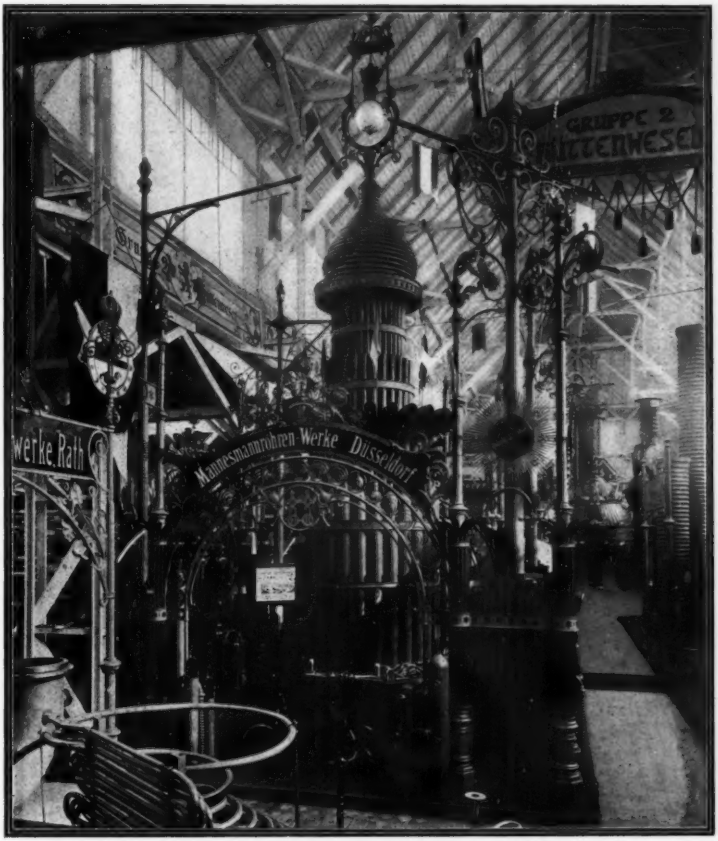


EXHIBIT OF THE MANNESMAN TUBE WORKS, DÜSSELDORF.

The total extent of the exposition grounds is 5,830,000 square feet, or about 140 acres, the portion, covered with buildings being about 40 acres. The buildings cover more space than those of the Paris exposition of 1867, and very nearly as much as the Vienna exposition of 1873—two to four times as much space as the previous German expositions of Nürnberg, Leipzig, and Berlin. The figures of these comparisons are furnished in the official guide, which ignores the Columbian exposition in Chicago in 1893, as well as the lesser undertakings at Omaha, Buffalo, and Charleston. Düsseldorf gives some interesting figures showing the relative importance of human affairs:—

Main Industrial Hall	318,000	square	feet
Machinery Hall	156,000	"	"
Gallery of Fine Arts	86,000	"	"
Restaurant	30,200	"	"
Wine Room	20,500	"	"
Power House	15,000	"	"

The committee in charge did not see its way clear to take the risk of removing the machinery hall, built of iron, after the exposition was over; so they arranged to borrow the building for a fixed payment from the firm building it, and this firm, in order to lose as little as possible, put up the building with reference to its ultimate removal and salvage. Its situation and its width were determined by the condition of the ground. It must be above high-water mark; it could not be very wide, so it had to make up in length for the curtailment in width. The result is a long hall in three sections, of which the central and main hall is 80 feet wide and 920 feet long, the two wings being each 45 feet wide. The central hall is provided with three electric travelling cranes, each of 30-tons capacity, and a running height of 35 feet. Each of the wings has four electric cranes of 10- to 15-tons capacity and a height of 22 feet. That the eleven travelling cranes are all electric indicates to what extent, in this line at least, electricity has won in the race with steam.

For purposes of illumination electricity shows no such victory. At Buffalo there was only electricity and acetylene, but at Düsseldorf there are electric lights, alcohol incandescent lights, city gas, compressed gas, and incandescent kerosene lights of the Washington patents. Nevertheless electric lights exceed all others, numbering 4,000 incandescents and 1,000 arc lights. 12,000 electric horse power is generated on the grounds, of which one-half is for supply of power and the other half for lights. The prime movers are twenty-six steam engines with twenty-seven, nearly all direct-coupled dynamos. For direct current both 115 and 220 volts are used, but nothing higher. In the triphase, currents of 2,000 and 5,000 volts are employed and alternating currents of 10,000 volts.

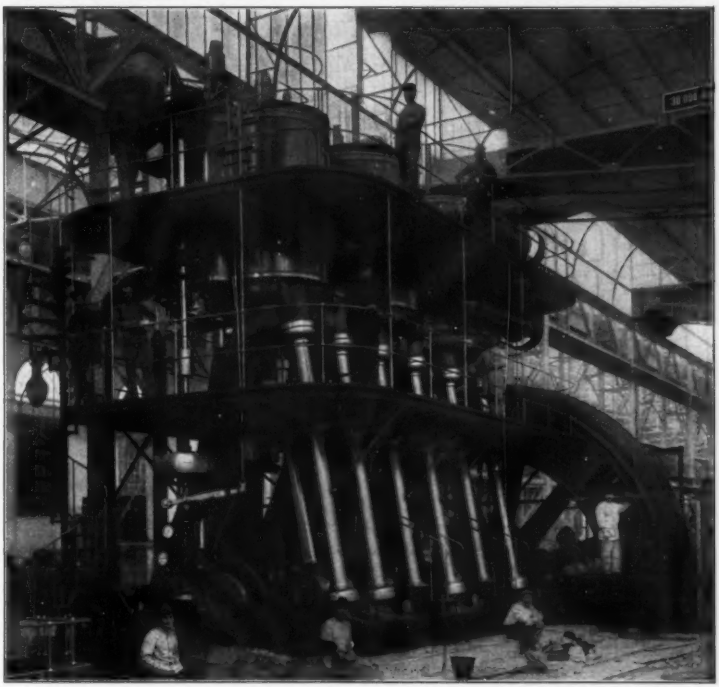
Water is drawn mainly from the Rhine by four electrically driven centrifugal pumps with a combined capacity of 18,500 gallons a minute and an average elevation of 25 feet. The electric motors are variable in speed in order to be adjusted to the rise and fall of the river. There are also at the Rhine station two high-pressure centrifugal pumps with a capacity of 1,320 gallons a minute.

Electricity is generated by four tandem horizontal engines developing altogether 5,000 horse power, four compound horizontal en-

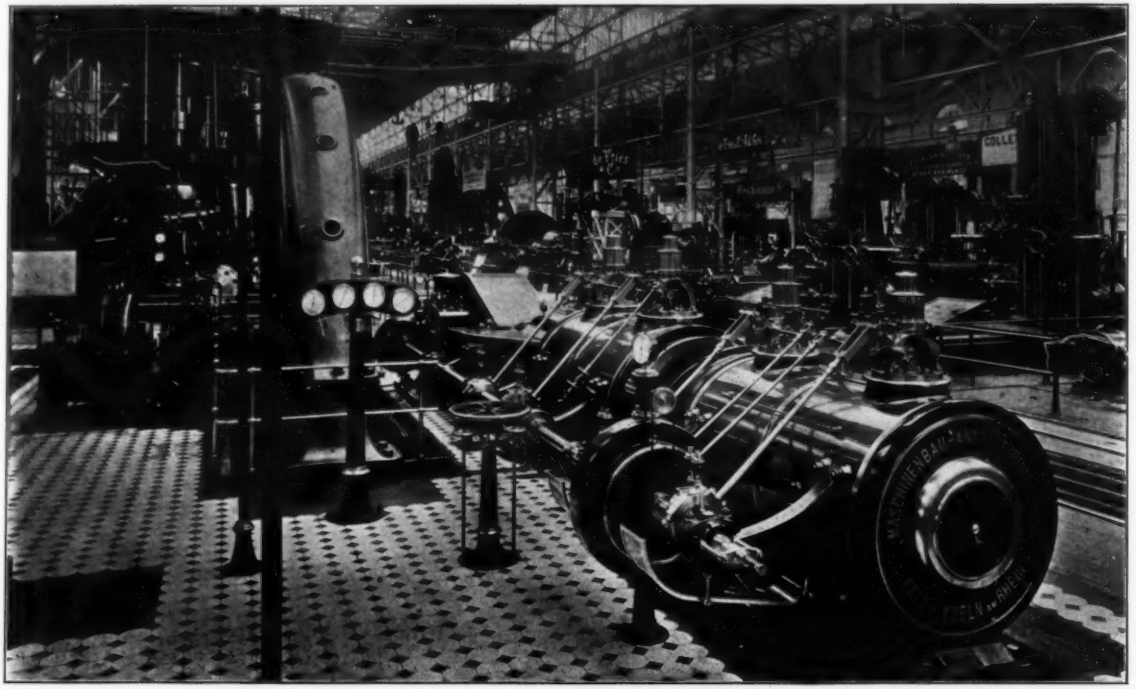
gines giving a total of 1,700 horse power, one three-cylinder vertical engine of 2,750 horse power, seven compound two-cylinder vertical engines, totalling 2,550 horse power, four horizontal one-cylinder engines with a combined output of 220 horse power, one De Laval steam turbine of 100 horse power, and two gas engines, one of 250 and the other of 50 horse power, yielding a total of 12,620 horse power.

There are two power stations, one for bituminous coal and the other for the brown or lignite coal. In the former are sixteen boilers, in the latter three. Gas engines, large and numerous, are installed for power purposes but cut a very insignificant figure in the generation of electricity.

A little railroad run with storage batteries curves through the grounds. Its length is 1.3 miles, the fare 20 pfennigs, the speed a little more than seven miles an hour. To meet the requirements of varying passenger demands the cars run on 5-minute headway with-



VERTICAL TRIPLE-EXPANSION ENGINE AND DYNAMO, GUTEHOFFNUNGSHÜTTE.
The largest engine in the Exposition, 3,500 horse-power, 94 revolutions.



THE MACHINERY BUILDING. HORIZONTAL TANDEM-COMPOUND ENGINE WITH DYNAMO, HUMBOLDT WORKS, IN THE FOREGROUND.
400 horse-power, 94 revolutions.

out trailer from 10 until 2 o'clock, from 2 until 5 on 2½-minute headway, from 5 to 8 P. M. with trailer on 2½-minute headway, and from 8 to 10 on a 5-minute headway without trailer. The motor car carries forty passengers, the trailer thirty, and tickets are secured from slot machines, an arrangement that might with convenience to the public be introduced on the elevated lines in America.

PART OF EXHIBIT OF THE GUTEHOFFNUNGSHÜTTE COMPANY, OF OBERHAUSEN.
Double tandem hauling engines and Riedler high-voltage 450-horse-power electric-driven pump.
By courtesy of the Scientific American.

Only in the most general way can a review be made of some of the exhibits.

Krupp's pavilion covers 45,210 square feet and his prize exhibit is the hollow crucible crank shaft forged from an ingot 12 feet 9½ inches long, 6 feet in diameter, and weighing 80 tons, cast from 1,768 crucibles by 490 men in 30 minutes, forged under a 5,000-ton press in 62 hours, with 22 heats, to a length of 135 feet. The lathe on which it was turned and bored was, length of bed 166 feet 4 inches; useful length, 152 feet 6 inches; swing, 31.5 inches.

In 1840 a forging of 800 pounds was large; in 1851 Krupp exhibited a block of 4,000 pounds; in 1855, 6,000 pounds; in 1861, 50,000 pounds; in Paris in 1867, 80,000 pounds, and in 1887, 170,000

pounds. The present maximum for crucible steel is 85,000 kilos, but the forge is able to handle single pieces weighing 120,000 kilos.

More important than big lathes, big forging, and big castings, are the exhibits of modern rapid-cutting steels, originally developed by Taylor and White at the Bethlehem Iron Works and since put on the market by many steel manufacturers. Krupp shows tools which cut 150 feet a minute (on cast iron 120 feet) and take off 194 kilos an

DISPLAY OF THE HORDE BERGWERKS & HÜTTENVEREIN.
Boiler plate 22.5 metres by 3.2 metres suspended on the left.

hour. These Krupp tools run several hours without grinding, sometimes days or even weeks, and with a sufficiently strong lathe increase the output four to six times.

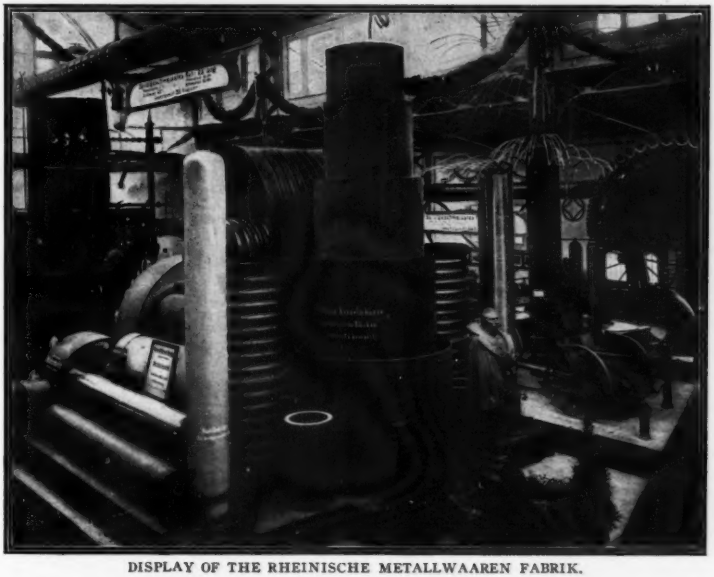
Another very interesting exhibit of Krupp's are the rock drills, some of them 20 feet long and of great weight, 4 inches square in cross section. They are forged from Martin steel, with an inserted and welded-in wedge of hard crucible steel. Some of these rock cutters have struck 250,000 blows. One of them broke down 35,000 cubic yards of hard slate with 165,000 blows. Krupp also exhibits a torpedo air reservoir 18 inches in diameter, 28/100 inch in thickness, which only yielded, splitting open, under a hydraulic pressure of 3,800 pounds per square inch.

There are also designs of small marine engines, 170-horse-power

triple-expansion, 10-inch stroke, of which the total weight, including boiler-room equipment, propeller, and connections complete, is 60 pounds per indicated horse power, or, forcing them to 210 horse power, the weight is 50 pounds per indicated horse power.

The Riedler fast pumps at 300 revolutions per minute, pump 8.2 cubic feet of water per minute to a height of 1,968 feet. The electric motor, 200 revolutions per minute, is driven by 450-horse-power triphase 2,000-volt current.

Notable improvements are also shown in hydraulic cements. The so-called iron Portland cement sets very fast and at constant volume. It is made by adding, in exact proportions, finely ground, granulated blast-furnace slag to clinkered Portland cement. So important are exact proportions that to avoid human error, all weighing and mixing are done automatically.



DISPLAY OF THE RHEINISCHE METALLWAAREN FABRIK.

The Düsseldorf exposition is probably the largest and most complete exhibition the world has seen of everything appertaining to heat engines and steel-working machinery, beginning with the mining of lignites and coal, their use under boilers and in gas producers, steam engines both of the reciprocating and turbine type, hydro-carbon engines of all kinds, from the rich kerosene to the lean blast gas, these

last giants in size. The power generated is transformed into electricity by direct, alternating, and triphase currents, which in turn drive high-speed reciprocating or centrifugal pumps, move heavy cranes, turn lathes and other machine tools, make incandescent and arc lights and charge batteries for the Exposition railway.

Iron and steel are on hand, from the sections of ore and rock to the highest samples of piano wire, torpedo-reservoir sheets, self-hardening tools which cut when red-hot, iron and steel made by almost every known process—cast, puddled, crucible, Bessemer, Martin, acid and basic processes; steel cast, forged, welded, drawn hot and cold; steels that do not corrode in sea water, or that do not crystalize or do not expand with temperature variations; steel made into needles and almost microscopic screws and watch-springs; ingots of crucible steel

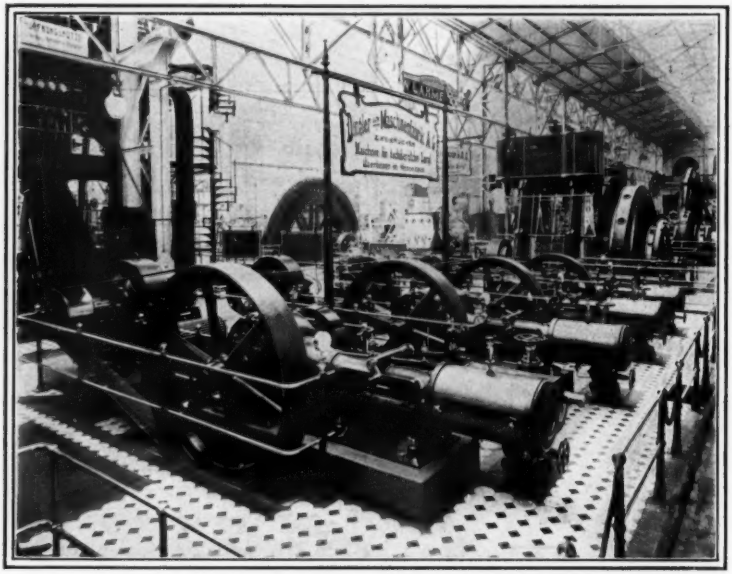
PRODUCTS OF THE PLATE MILLS OF SCHULZ KNAUDT ACTIEN GESELLSCHAFT, ESSEN-RUHR.

EXHIBIT OF THE GEWERKSCHAFT GRILLO FUNKE & CO., SCHALKE.

weighing 80 tons, forged into shafts 135 feet long, the shafts turned and bored on monster lathes. To the layman steel is steel, but these steels are as specialized as the trotting horse or the German university professor—pre-eminently, superlatively good for one thing.

In comparison with the iron, steel, power and machine exhibits, the great chemical and technical display pales, and the assembled art treasures of modern Germany become an anachronism. The art of the future is as distant from the art of the past as the iron and steel of Cortes and Pizarro are different from the engines of the Inchkeith or of the Deutschland. Bathing nymphs, fighting centaurs, fossilized landscapes, idealized portraits, no longer hold our attention. The moving pictures, the delicately tinted Japanese slides, the marvellous portrait photographs, all stimulate and inspire where the modern gallery depresses. The artist who spends weeks on a single production finds his reward in the work. He sees the soul of things, even though he fail to interpret satisfactorily for others. The engineer who listens to the hum of the 24,000 revolutions per minute of the steam turbine, who photographs the insect or bullet in flight, who measures the radiations from radium, will be satisfied with no less than pictures of the soul itself.

As a whole, the Düsseldorf exposition is unquestionably great. Yet with admiration for the varied and splendid productions, there is disappointment that to only a limited degree have possibilities been



INTERIOR OF MACHINERY HALL AT DÜSSELDORF.
By courtesy of the Scientific American.

realized. What of the humanity back of all this effort? Do men exist for the sake of steel? All the influence of Krupp, for example, and all his intelligence, might have been directed *against* the utterly wasted and unproductive implements and paraphernalia of war—might have gone instead into productive German machines.

Stores of the two elements, carbon and iron, deep in the earth, have made Düsseldorf the center of one of the greatest industrial regions in the world. With 8 pounds of steam per horse power hour the steam engine has almost reached the pole of its endeavor; 90-per cent. efficiency in water wheels and dynamos, steel of 200,000-pounds tensile strength—in these directions there is little more to be done; but the average efficiency of man is as yet scarcely one per cent. Many men are many times more efficient than the average; yet who can deny that with wider opportunity or more wisely directed efforts they could not have done tenfold more? Beyond prophets' dreams that nation will surpass its competitors that first learns to make its humblest workman the master, not the slave of his task, thus increasing his potential efficiency to a marked degree.

ORDNANCE ENGINEERING AS A MECHANICAL INDUSTRY.

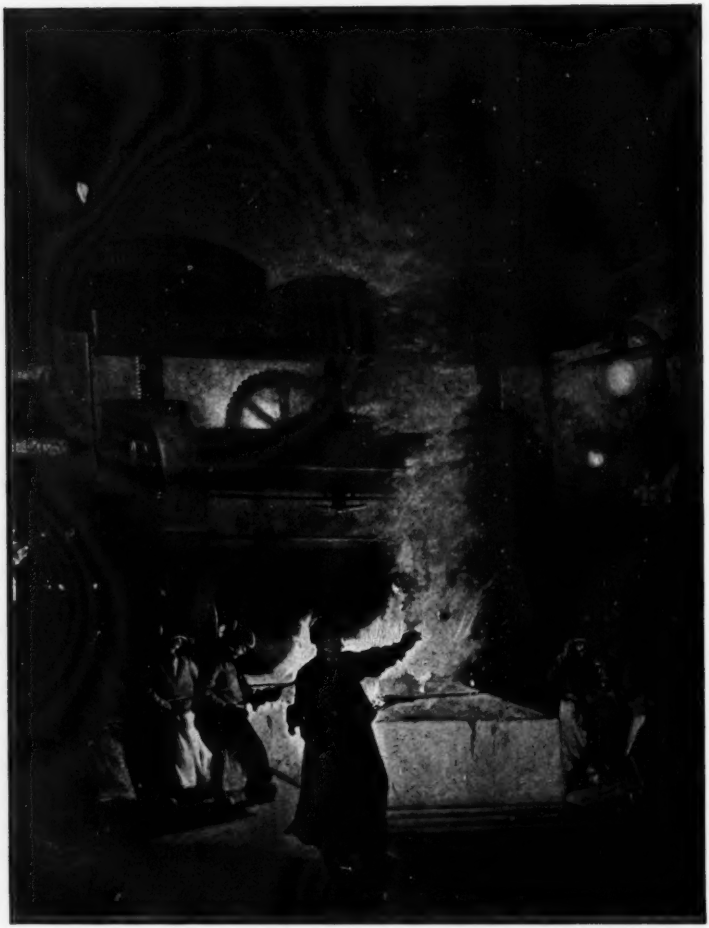
By J. F. Meigs.

The mechanics of ordnance engineering have two phases of great interest—first, the wonderful ingenuity developed both in the design of the gun and its mountings and in the processes of manufacture; second, the dynamics of the gun itself regarded as a huge engine for directing and controlling immense forces. It is rather with this second aspect that Mr. Meigs deals.—THE EDITORS.

The Muzzle of the 16-inch Gun.

ORDNANCE engineering is concerned with the design and construction of the implements of the attack and defense of nations. At the present time there are in the world more than one hundred armored battle-ships under construction, and the coasts and land frontiers of countries are being defended with elaborate systems of fortifications and guns. These defensive arrangements have greatly increased in modern times, and it is now recognized that they are necessary to national safety. The guns in the above classification include only what are called "guns of position," and besides these, all of the Great Powers have stationary and movable torpedoes, field, siege, and mountain artillery, and, descending again in the scale, they have hand weapons, consisting of rifles, pistols, etc. Included in the term Ordnance is everything pertaining to the above, and to its design and manufacture, and we thus see that the ordnance offices of the Great Powers of the world spend very large sums of money, and control what is perhaps, on account of the great variety of the range of the contributory sciences, as complex an output as is to be found.

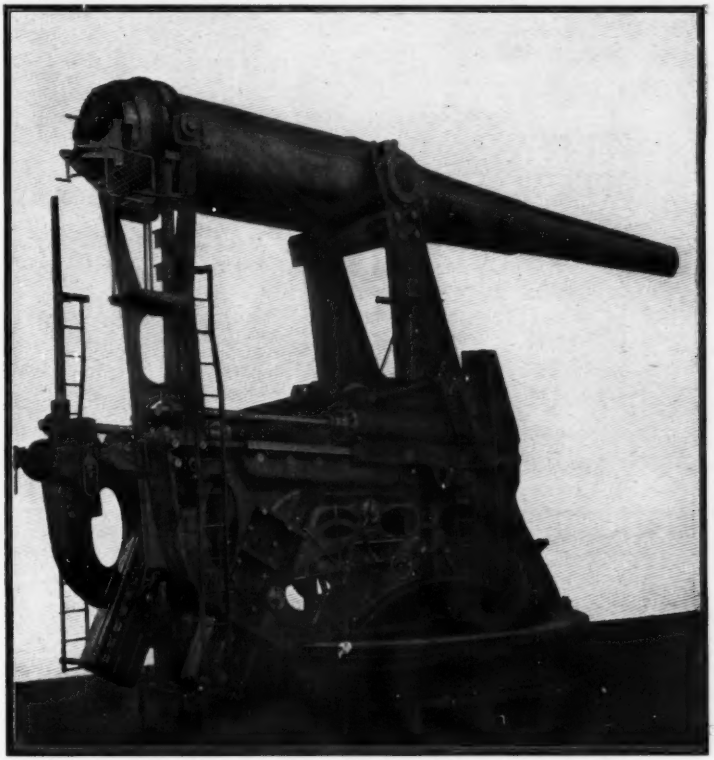
In speaking of ordnance people generally have in mind a gun alone, but they should consider with the gun the means of resisting its attack. The means of resisting the attack of guns consists in "cover." Ships carry over their principal parts and guns, steel armor plates, while lines of skirmishers on shore seek cover behind such natural objects as each individual skirmisher can find. The art of resisting the attack of guns, then, may be said to lead to two extremes. In the one the important things are concentrated into a small space and are covered with armor



THE ARMOR-PLATE ROLLING MILL AT KRUPP'S, ESSEN, GERMANY.

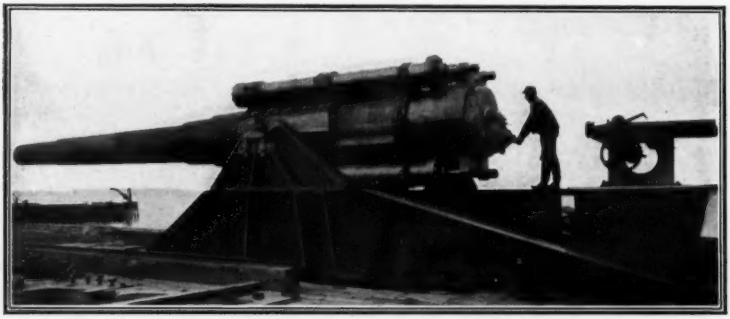
plate, or stone or earthworks, if on shore. At the other extreme we find the dispersion of the skirmish line, or at sea, the "clouds of small vessels," which some people would prefer to build rather than battleships. Not many years since it was thought by some that it was better to build fifty torpedo boats costing $100,000, rather than one battleship costing $5,000,000. No doubt the torpedo boat, with her deadly torpedo (representing sub-aquatic ordnance), if she can lay out the

game in advance, can get the better of the battle-ship. But the view is prevalent now that, while there should be some torpedo boats, the bulk of the money and effort put into naval and coast defenses should go into battle-ships and fortifications. The battle-ship can go anywhere, while the torpedo boat, because she cannot carry much coal, is tied to the home port, and in bad weather, when the battle-ship is comparatively steady, the torpedo boat would, at any speed, tear herself to pieces in the heavy seaway. In the same way, in land defense, the bulk of the money and effort is now put into permanent defenses and field artillery. Nations have also supplies of ammunition and portable weapons, but in the preparation which goes on in peace time the bulk



12-INCH GUN ON DISAPPEARING CARRIAGE; BETHLEHEM STEEL COMPANY.

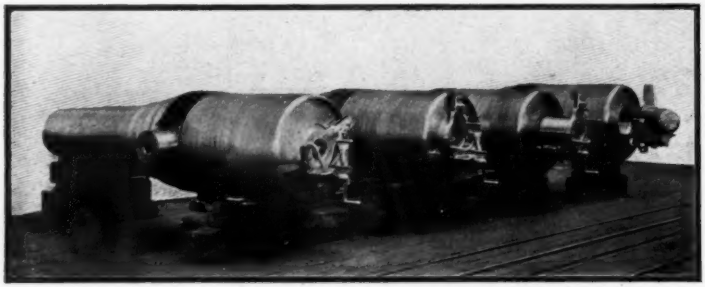
Characteristic weapon of U. S. coast defense. Weight 50 tons. The lever arms permit the gun to drop 9 feet behind a parapet after firing. It is returned to battery by a counterpoise.



13-INCH GUN OF THE AMERICAN NAVY, WITH HYDRAULIC RECOIL CYLINDERS.

of the money and attention goes to putting in the great land defenses on the frontiers.

There is, probably, no feat of modern engineering so wonderful as the building and equipping of great battle-ships. Not only must everything in them be strong, serviceable, and compact, but, since every ton of load the ship can carry is so much offensive or defensive power—that is, is so much weight in guns or armor—everything must be as light as possible, and the full power of everything put into the gun must be utilized. If of two guns of a certain weight one will strike a more effective blow than the other, then that gun is the one to choose. Similarly the armor of a given thickness which will offer the greatest resistance to penetration is the best and must be had at any cost. If we go into a modern battle-ship and go over her, there are no places in her which would so fill us with wonder, and, it may be added, a certain amount of uneasiness, as her engine room and her gun turrets when in operation. In the latter, if she is a large ship, she will carry 12-inch or



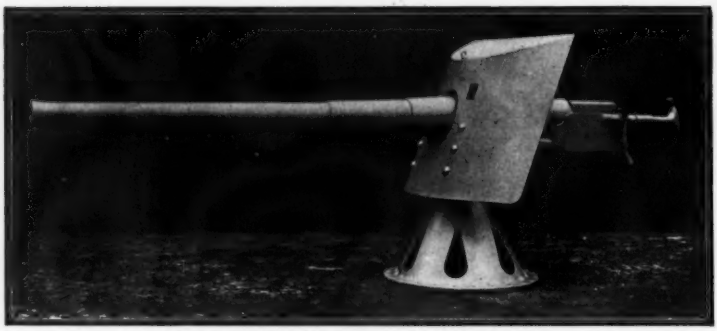
A GROUP OF 12-INCH MORTARS, AT THE BETHLEHEM WORKS.

The mortars throw a projectile weighing 850 lbs., at very high angles, with the purpose of attacking an armored ship by piercing her deck.

13-inch guns, probably, and these, weighing from 50 to 60 tons—about the weight of a fair-sized locomotive—will, when they are fired, be projected to the rear at a rate of about 25 feet per second, or say 17 miles an hour. By their hydraulic recoil brakes, in which resistance to the motion of a piston in a fluid-filled cylinder is by means of a rod utilized to restrain the gun's recoil, the gun will be stopped in about 36 inches, and will be returned to its firing position by a powerful coiled spring. So quick is the stroke of recoil and return that the eye fails to

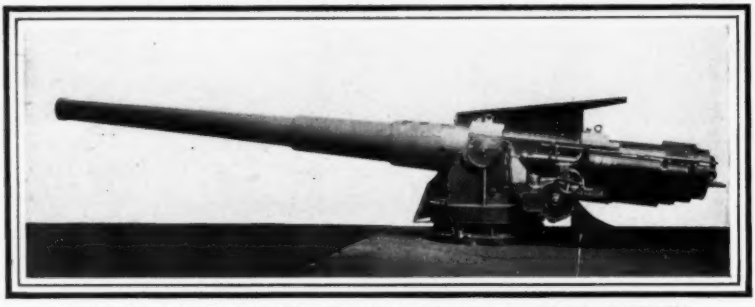
THE GREAT 16-INCH GUN AT THE WATERVLIET ARSENAL, N. Y.
By courtesy of Col. J. P. Farley.

appreciate it, and devices are used in gun turrets to prevent the gun from being loaded twice, from a mistake on the part of the gunners in supposing that the gun had been fired when it had not. Nothing, perhaps, gives an idea of the immensity of the forces in play so well as the snapping of a 50-ton weight to the rear and forward again so quickly that the human eye can hardly see it. On land, again, we have the so-called disappearing mountings, on which a gun is carried on a pair of long rocking levers. Upon firing, the gun of 50 or 60 tons is dropped behind a parapet, and, upon throwing a lever, after the gun has been loaded in its lower position, the gun rises above the parapet again, and is once more ready to be fired.



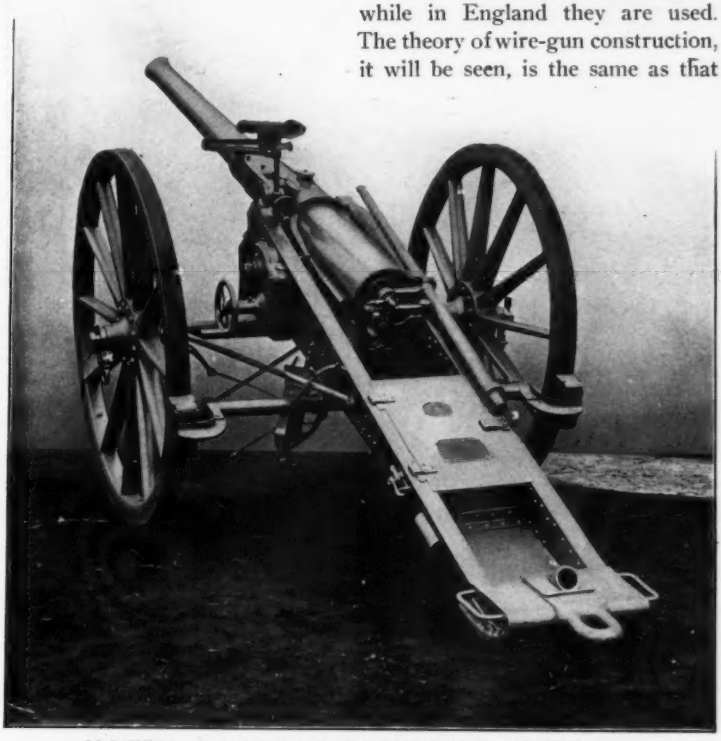
14-POUNDER 3-INCH SEMI-AUTOMATIC GUN.
Vickers, Sons, & Maxim, Ltd.

At the other end of the scale we have the "automatic" guns. The automatic feature has not been used much in any gun throwing projectiles of more than one or two pounds weight. These it will throw, in the case of the smaller calibers, at the rate of several hundred a minute, so that the bullets can be directed by the gunner to any point, in the same way that he would direct a stream of water from a hose at a point. Still a great many military and naval men, not to say the majority, do not believe in the use of the automatic feature on even one-pound guns, because an automatic gun must weigh more than one that is hand loaded, and because it fires ammunition away so rapidly that it must run out of its ordinary supply in a few minutes. Still, an automatic gun that will throw projectiles at such speed, under certain circumstances may be a most useful weapon. To give an idea of this effect, it may be stated that it is easy to cut down large trees with the stream of bullets fired from an automatic gun, using projectiles such as are fired from ordinary shoulder guns.



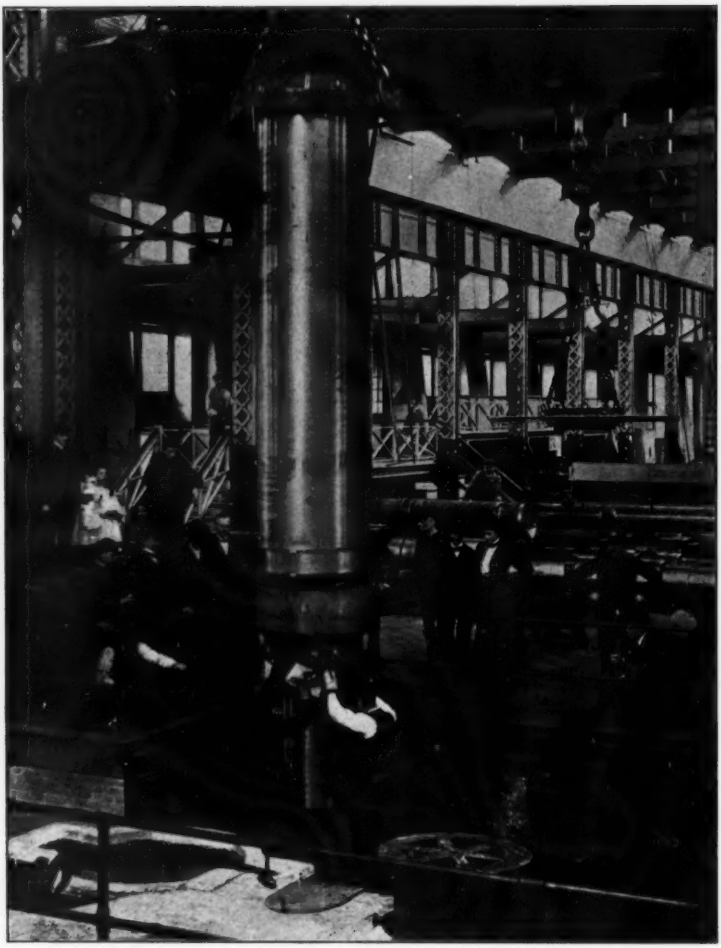
SCHNEIDER-CANET 24-CENTIMETRE RAPID-FIRE GUN ON NAVAL MOUNTING.

Guns are nowadays all built of steel, and successive tubes are shrunk on, one outside of the other, and thus a greater strength against internal powder pressure is reached than could be reached with a gun of one piece. Also, guns are built of wire sometimes, and the wire gives a greater margin of hoop or circumferential strength. On the other hand, a wire gun is less strong lengthwise, and the opponents of wire-gun construction say that guns are more apt to fail lengthwise than circumferentially. This is a large question, and one upon which a great deal of talent has been engaged for many years. It may be stated that neither the army nor navy of the United States, France, Russia or Germany, uses wire guns, while in England they are used. The theory of wire-gun construction, it will be seen, is the same as that



12-POUNDER 40-CALIBRE GUN FOR FIELD SERVICE, ELSWICK-BUILT.

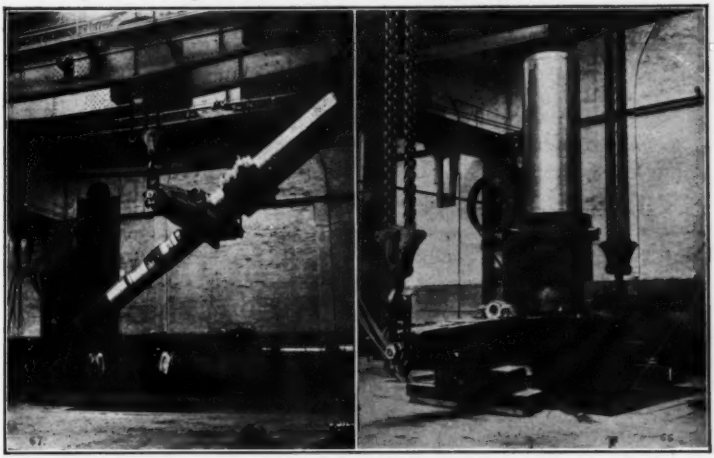
A battery of six of these guns was built for Lady Meux, who presented them to Lord Roberts. They were served in South Africa by a volunteer battery from Elswick. Muzzle velocity, 2,230 feet per second; range, 9,000 yards. The gun recoils in the line of fire, and recoil of the carriage is entirely suppressed by brake shoes and spade.



SHRINKING A JACKET ON A 13-INCH GUN TUBE, WASHINGTON NAVY YARD.

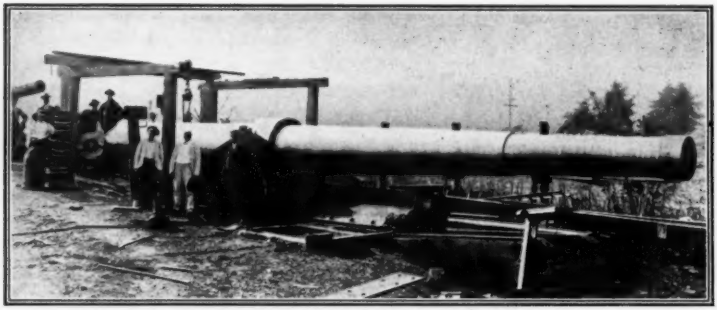
of using hoops shrunk together, except that with the wire you have, so to speak, a great many hoops, and the tension of successive layers as you go outwards is obtained by the pull on the wire in winding it on the gun, instead of by making the hoop which is to go on the outside of the gun smaller than the piece which it envelops, heating it, slipping it into its seat, and allowing it to cool there and grip the internal part.

Since each successive filament, as you go outwards in a gun's walls, pulls less and less when the powder pressure distends the gun's bore, it is evident that it avails very little to make the walls thick beyond a certain point. At present the walls are from one to one and one-quarter times the diameter of the bore. Also, theoretical reasoning indicates that the strength of a gun (a thick hollow cylinder) cannot be made greater than about 1.4 times the elastic strength of the metal of which the gun is made. Gun steel now has an elastic strength of from 45,000 to 65,000 pounds per square inch, with an elongation in a 2-inch bar of from 25 to 15 per cent. of its original length. There is a constant tendency to use harder and stronger steel.



PLACING AND SHRINKING ON THE HOOP OF A 66-TON GUN FOR THE JAPANESE GOVERNMENT, AT THE SCHNEIDER WORKS, LE CREUSOT.

The powder pressures in guns now rarely run over 37,000 pounds to the square inch, and it is doubtful whether, with modern powders, so high a pressure can be used, as modern powders are liable, when too great a weight of them is exploded in a gun-chamber of fixed size, to give dangerous pressures. It may be stated that all powders have *critical pressures*, and that when, by reason of employing too high a "density of loading" (that is, filling the chamber too full) these pressures are reached, variable, abnormal, and violent pressures which cannot be predicted, will supervene. The critical pressure of modern powders is lower than that of old powders. Modern smokeless powders cannot be used in large guns with safety at so great a pressure as 50,000 pounds per square inch. The older forms of powder, such



THE 18-INCH GATHMANN TORPEDO GUN.
Designed and built by the Bethlehem Steel Co. To the left and rear is seen the partially pointed projectile, and next to it the regular powder charge.

as that which was called brown powder, of only a few years back, could be used at as high a pressure as that just stated, but no one would like to use the approved modern powder, which is pure nitro-cellulose, higher than perhaps 35,000 pounds to the square inch, and those modern powders which are made up partly of nitro-cellulose and partly of nitro-glycerine could not be used at as high a limit as this. The limit for them does not exceed 30,000 pounds. When it is added that guns, even of large size, can be made sufficiently strong to withstand, with proper factors of safety, pressures of 40,000 to 45,000 pounds per square inch, while modern powders cannot be relied on to give steady and uniform pressures when worked to this point, it becomes apparent that much is to be desired in the powder. If powders are worked near their critical pressures, the products of combustion are believed to combine in differing ways, producing different "orders of explosion," and what are called "wave pressures" appear. Under these circumstances, abnormal and destructive pressures are created.

6-INCH AND 7.5-INCH GUNS AT THE PROVING GROUNDS.
Vickers, Sons, & Maxim, Ltd.

Besides the powder just referred to, which is that used for propelling the shot out of the gun and giving it its destructive energy, there is also the powder which is used to burst the shell. The qualities required of this latter are obviously different from those of the propelling powder. The former should give a long push to the shot, thereby propelling it without too great a strain on the gun, while the latter should act very suddenly and blow the projectile into small fragments. Late developments have led to the use of high explosives, generally

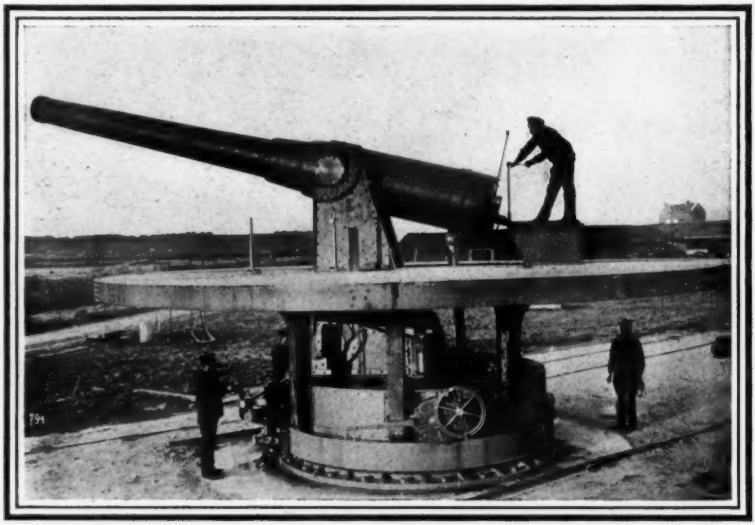
A 14-YEAR-OLD BOY SEATED IN THE BREECH OF THE GATHMANN 18-INCH TORPEDO GUN.

The photograph shows the velocity screens and the tunnel cut in the rock by the fire of projectiles. The view is at Redington, the proving ground of the Bethlehem Steel Co.

some form of picric acid, for the loading of shells. These are fired by suitable fuse, at the proper moment, and the whole arrangement of the details of the shell, its bursting charge, and the firing of the latter, constitute the most difficult part, perhaps, of ordnance.

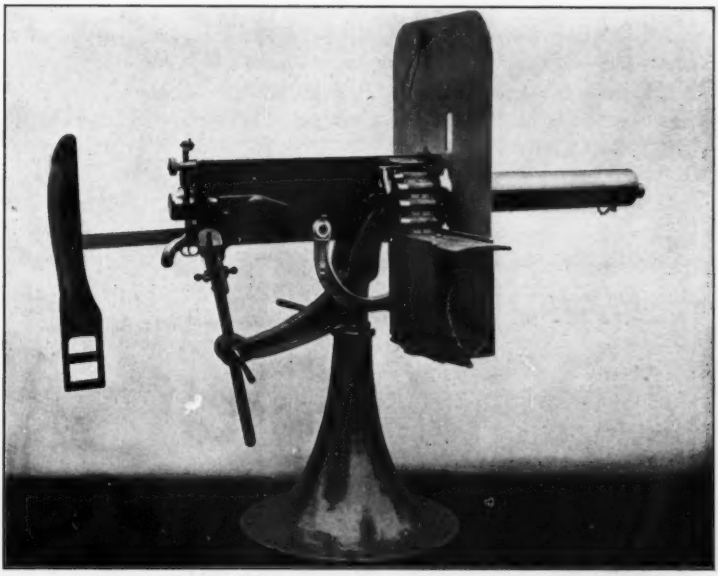
In saying just above that the propelling charge of the gun should push the projectile out of the gun with a long push rather than a short violent one, we have not exhausted the matter by any means. Modern powders are progressive, as it is called. That is, they burn in the

chamber with comparative slowness, and supplement the pressure on the base of the rapidly advancing shot by fresh additions of gas, until the shot is out of the gun. In guns suitable for powder of this class, the length of bore must be great and the powder chamber should be large in diameter. This necessitates obviously a heavy gun. In the older guns, which used black powder, the chambers were not so large nor the guns so long. Any one visiting the old arsenals of Europe and examining guns made 200 or 300 years ago, would see that their system in this regard was similar to that of the present day. We are now, by means of long bores and large powder charges, contained necessarily in large



SCHNEIDER-CANET GUN OF 27-CENTIMETRES MOUNTED ON DISAPPEARING CARRIAGE.

chambers, using the gun's weight economically, while 40 years ago guns were much less strong around the muzzle, the chambers were smaller, and the guns shorter, so that economy in ammunition was striven for rather than economy in gun's weight. It is a little curious that at the present time we are moving in ordnance in the opposite direction to that followed in the evolution of steam engines. We are using guns, or rather the powder in the gun, non-expansively. Neither are we materially raising the pressure in guns, while steam pressure is rising continually, and it would appear that, as the steel grows stronger, the powder pressures should be raised. This, however, is a question of the powder and its critical pressure, already noted.



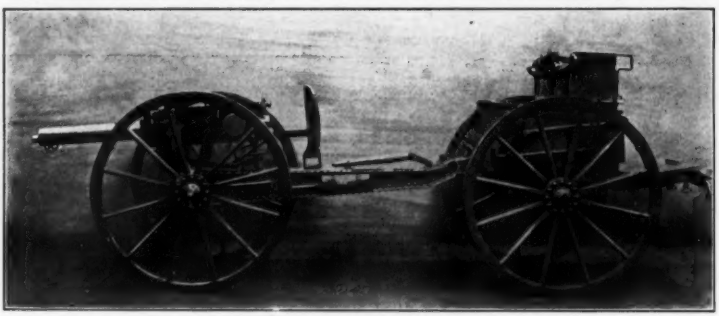
37-MILLIMETRE AUTOMATIC MAXIM GUN ON CONE MOUNTING.

BETHLEHEM STEEL COMPANY'S 3-INCH FIELD GUN AND CARRIAGE, WITH LIMBER.
Weight fully equipped, with 44 rounds, 3,958 pounds.

No less important than the gun is the gun mounting or carriage. Indeed there is more scope for improvement and betterment in the carriage than in the gun, and there is a particularly interesting development now going on in field-gun carriages. Formerly field guns were

4-INCH GUN FOR U. S. NAVY, BUILT BY THE BETHLEHEM STEEL CO.

fixed to their wheel axle, and when fired the gun ran with the axle and wheels to the rear, a distance of twenty or more feet, depending upon the obstructions on the ground. At present, however, everybody is demanding what are called rapid-fire field guns. In these the gun recoils on the axle, with a hydraulic recoil cylinder to stop it and return it to battery; and in consequence of this elastic joint, the gunner may sit on the trail of the carriage, the wheels remaining stationary on the



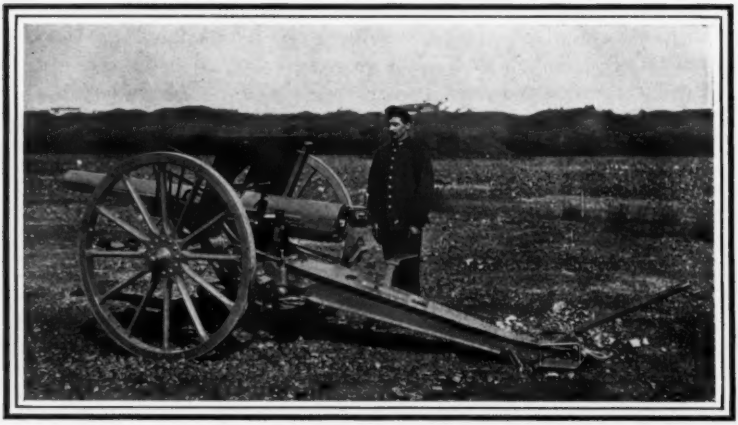
37-MILLIMETRE FIELD EQUIPMENT.
Vickers, Sons, & Maxim, Ltd.

ground, and the rate of fire is accelerated from four or five rounds per minute to twenty rounds per minute. The reader will note that the old fashioned *rigid* carriages, as they are called, which recoiled on the ground, had to be run back by hand to their position before firing—a

laborious and time-consuming operation—between each fire. While not increasing the total weight of the equipment behind the horses and maintaining the effectiveness of the gun, it is striking to observe that this incorporation of what is called rapid fire into field artillery has led to enabling one gun to deliver as many shots as four could formerly. Of course the modern gun with the elastic recoil arrangements is more complicated than the old rigid gun, but if it can fire four or five times as often, it would appear that the modern complicated gun has come to stay, and that the men who handle it must become mechanics.

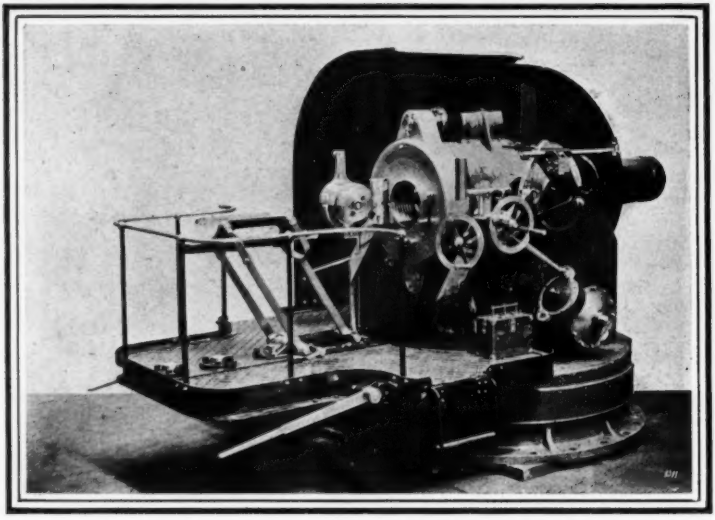
BETHLEHEM STEEL COMPANY'S 3-INCH MOUNTAIN GUN STOWED FOR TRANSPORTATION.

The mountings for ship guns and guns in coast fortifications are very much the same, and are so designed and constructed as to throw into the power of one man, in so far as possible, the whole control of directing the gun at the desired target and firing it when ready. The loading of the gun and the opening and closing of the breech block is performed to the rear of the man firing it, and therefore out of his sight, and certain interlocking arrangements in the firing apparatus are so devised as to prevent him from firing the gun unless the breech block is fully closed. Admiral Lord Collingwood, who was second



THE SCHNEIDER-CANET 75-MILLIMETRE RAPID-FIRE FIELD GUN, MODEL OF 1901.

in command to Nelson at the battle of Trafalgar, was in the habit of telling his men that, if they could fire three well-directed broadsides in two minutes, they were certain of victory. Their guns weighed about 2,400 pounds. The modern 6-inch breech-loading gun, which weighs



24-CENTIMETRE SCHNEIDER-CANET HOWITZER OF 10 CALIBRES ON NAVAL CARRIAGE.
Schneider & Cie, Le Creusot, France.

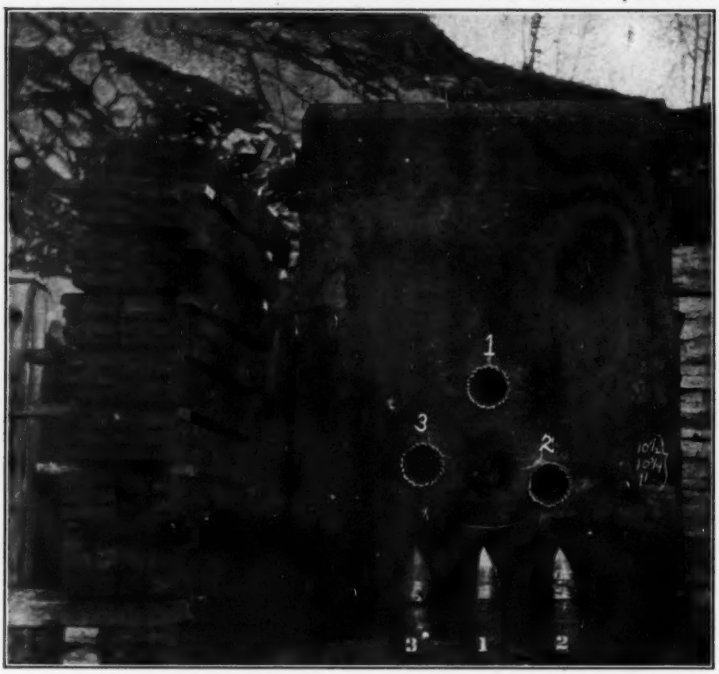
12,000 or 15,000 pounds, has been fired eight times within a minute at a target about 1,500 yards distant, probably quite three times the distance in Lord Collingwood's mind, and struck the target each shot. The difference here shown is due principally to the mounting. It is due, in some degree, to the fact that the modern gun is breech-load-

TWO VIEWS IN THE U. S. ARSENAL AT WATERVLIET, N. Y.
The upper picture shows the gun-jacket boring and turning lathes, the lower a row of boring and turning mills. The tools are of Niles make.

ing, but the quicker rate of fire must be ascribed in large measure to the excellence of the mounting.

Armor plate, which now constitutes the protection universally employed by ships of war and in many land fortifications to resist the attack of projectiles, is super-face-carbonized and hardened steel.

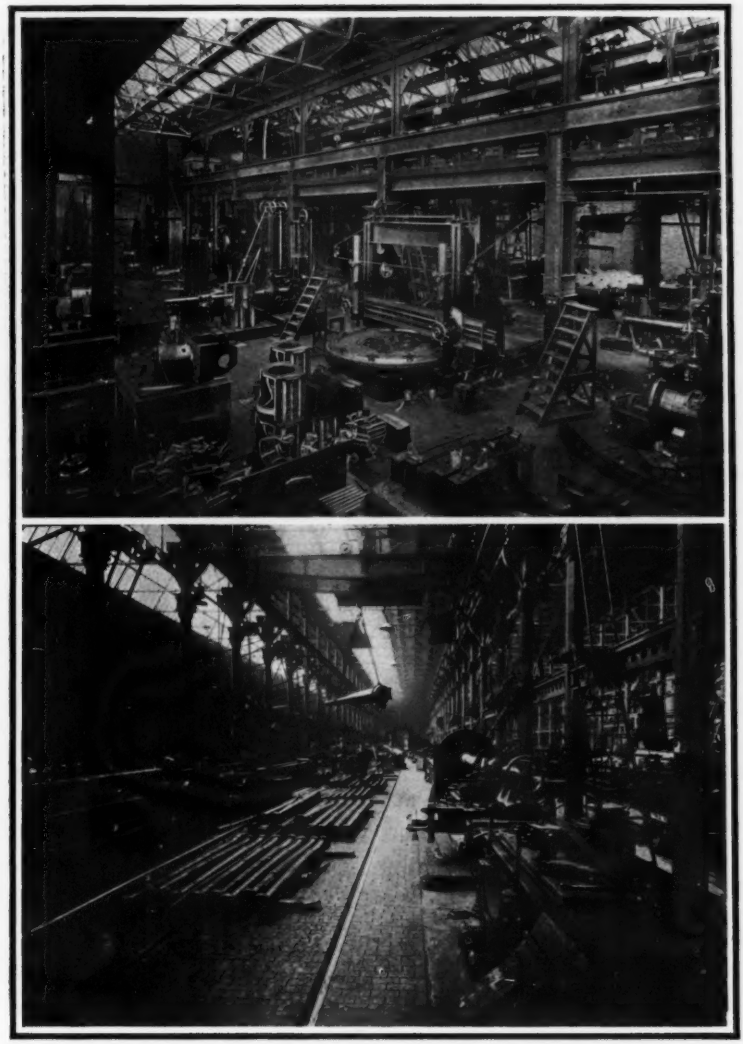
Some thirty years ago what was called *compound armor* was used in Europe. This consisted of a face of hard steel burned or welded onto a backing of comparatively soft metal; and there exists a close analogy between this and the present super-carbonized and face-hardened armor. In the compound variety, however, the joint between the soft and the hard metal was never good, and when an armor plate was struck by a shot, large areas would be stripped of the hard face. The hard face, produced by super-carbonization, is much more adherent, but, it must be added, is not so thick as that which can be produced



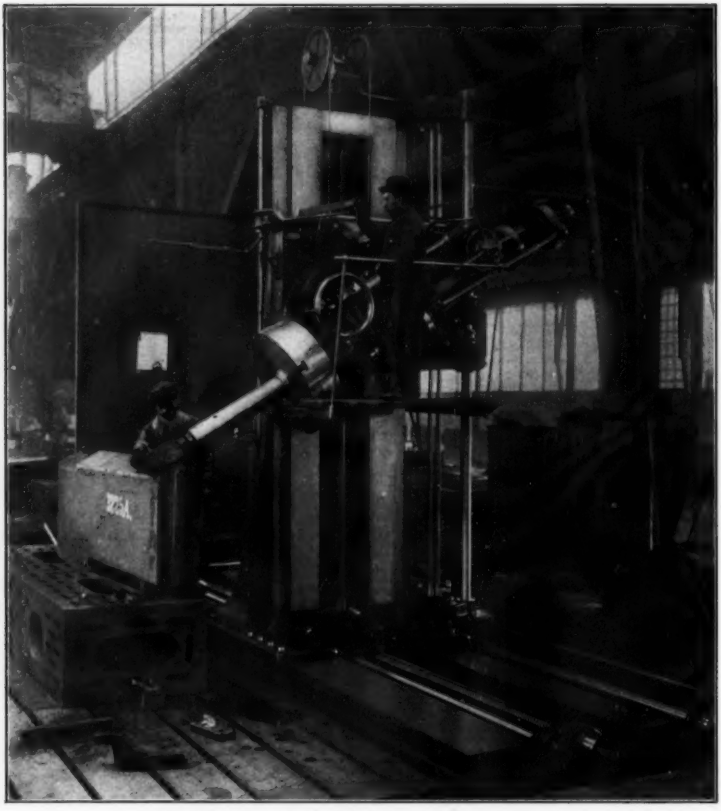
TEST PLATE OF THE TURRET OF THE U. S. S. MAINE, SUNK IN HAVANA HARBOR.
These plates were not face-hardened, but were homogeneous steel. The "fringe" which squirted toward the gun is well shown. Photograph taken at the Bethlehem Steel Co.'s Redington proving ground.

with compound armor. Upon the whole, however, modern armor is far more resisting than that of former times.

The office of the hard face in armor is to cause the rupture of an attacking projectile. The projectile makers are striving so to design the form of the projectiles, and so strengthen them, that they can meet



VIEWS IN THE ERITH WORKS OF MESSRS. VICKERS, SONS, & MAXIM, ERITH, KENT.
Above is the carriage department; below, the gun-mounting department.

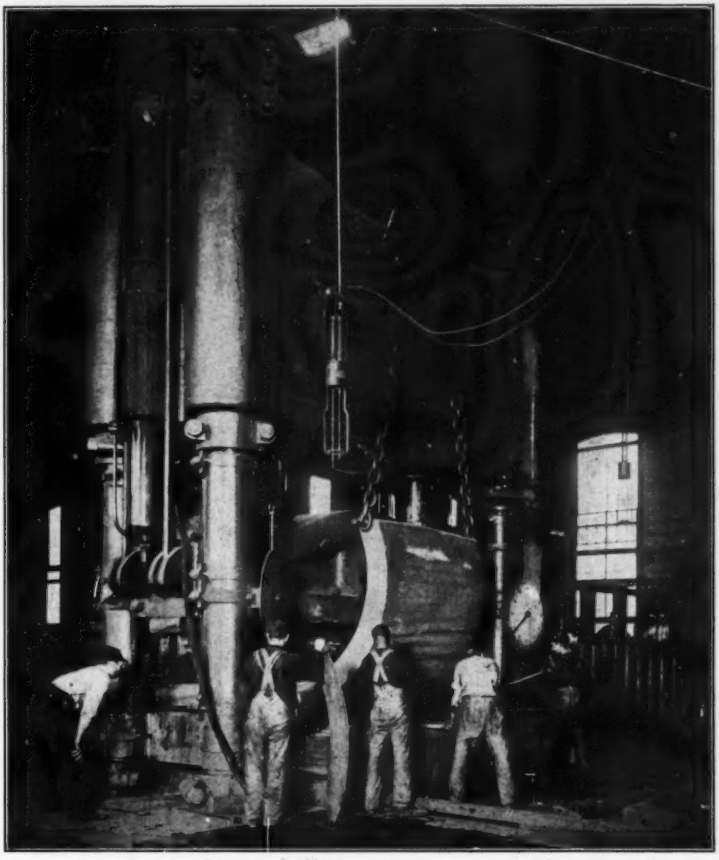


MILLING AN ARMOR PLATE TO THE PROPER BEVEL.
Fried. Krupp Works, Essen, Germany.

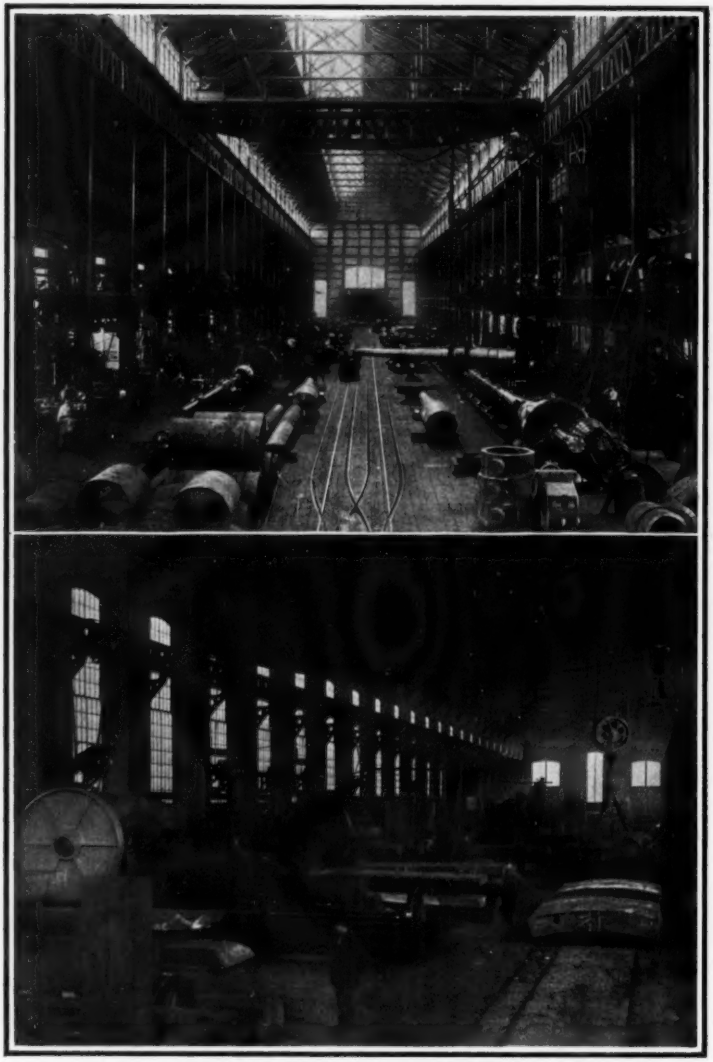
the glass-hard 2-inch-thick face of an armor plate (say from 4 inches to 12 inches in total thickness) and break through it before they themselves are broken. To this end the working end of the projectile—its forward end—is glass-hard, while its rear, like the rear of an armor plate, is soft and tough, and will yield and not break. Thus between the armor plate and the projectile there is a constant rivalry, and in the past fifteen years the armor plate has become from two and a half to three times more resisting, while the projectile has not improved so much. Owing to improvement in design and in material and tempering the projectiles have advanced somewhat, and in the use of the

soft cap on their noses, rediscovered some few years back, they have materially gained.

Iron armor first came to be used about the year 1860, simultaneously in America and in Europe. In the American civil war, as is well-known, it was used to a great extent. At that time so-called laminated armor was used, consisting of a number of plates 1 inch or 1½ inches thick. The metal of these plates was comparatively soft. Following these came thicker plates, in which the whole thickness of armor was in one solid piece. This was a great improvement, and plates of as



7,000-TON ARMOR-PLATE-BENDING PRESS, BETHLEHEM STEEL CO.



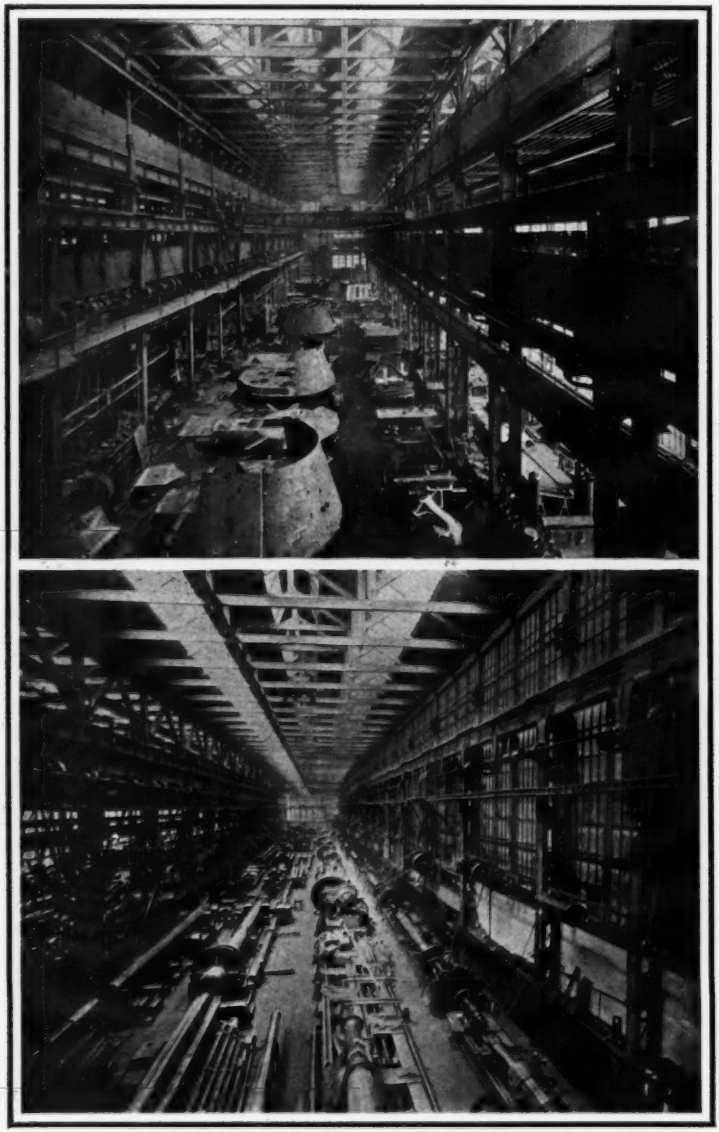
THE UPPER VIEW SHOWS THE GUN SHOPS AND THE LOWER VIEW THE ARMOR-PLATE SHOPS, BETHLEHEM STEEL COMPANY, SOUTH BETHLEHEM, PA., U. S. A.

much as 20 inches thickness have been used. The use of compound armor and of super-carbonized faces came later, and they are manifestly improvements on the so-called homogeneous armor, which is of one degree of hardness throughout.

The question of getting a sufficient supply of ammunition to the guns, whether in the field or on the broadside of the ship or in her turret, is perhaps the most difficult of all tasks set the ordnance engineer. Not only must the ammunition be moved rapidly, but it must be moved safely and securely, and the bringing up from the bottom of the ship

INTERIOR OF THE KRUPP ARMOR-PLATE SHOP.

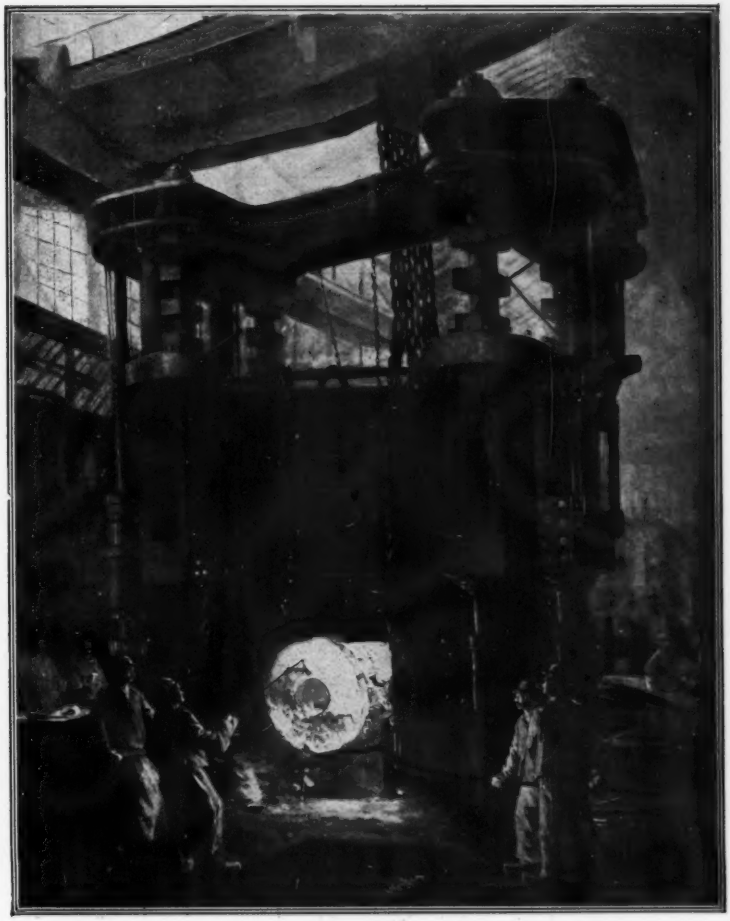
to her very top, that is, carrying through the 30 feet between her magazines and her turrets, a couple of rounds consisting each of a 1,000-pound shot and about 300 pounds of powder, in each minute, is not easy to arrange for. It may be noted in passing that most of the appliances are electric, and that interlocking arrangements must be provided to prevent the performance of operations in the wrong way—to prevent, for example, the gunner from attempting to raise or lower the breech of the gun while the charge is being rammed into it. On land, the supply of ammunition, from that of the skirmish line, now attempted by means of dogs, to that of the 12-inch rifles in the coast fortifications, constitutes also a most difficult task. Indeed, as every



PORTIONS OF THE ELSWICK WORKS, NEWCASTLE-UPON-TYNE, ENGLAND.

Above is shown tbe erection of turntables and turrets for 8-inch guns. Below is one of the large machine shops for turning and rifling heavy guns. The shop takes guns from 12 down to 6 inches.

6-inch gun and guns of smaller size may be fired effectively several times a minute, and as each 12-inch turret or barbette gun may be fired once in a minute or in a minute and a half, we may affirm, without



THE 5,000-TON FORGING PRESS, KRUPP WORKS.

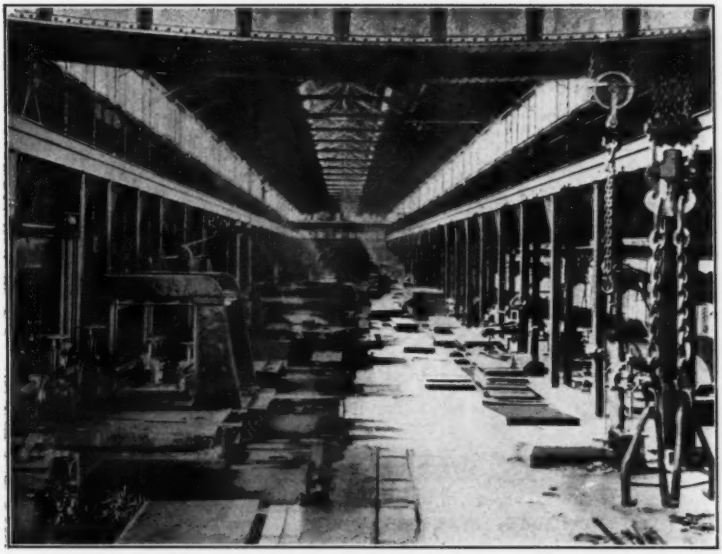
fear of contradiction, that the guns are better arranged than are the methods of supplying them with ammunition; for no ship could bring her ammunition up as fast as is indicated. We have an almost parallel difficulty in the matter of coaling ships, and in the delivery of the coal

to their furnaces, for in many ships coal can be burned up faster than it can be put on board, and in some, under adverse circumstances, it cannot be got to the furnaces as fast as the furnaces can burn it up. Obviously there is no use in putting complicated arrangements leading to quick firing on the guns, unless the ammunition can be brought to the gun fast enough, nor is there any use in putting into the hands of

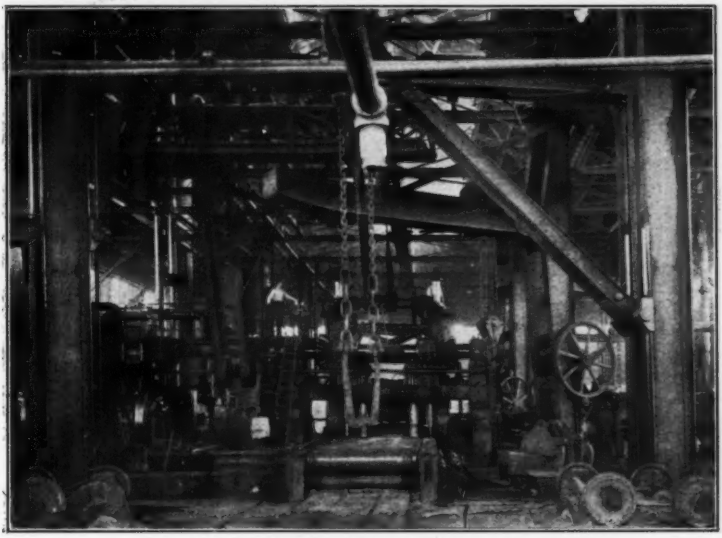
12,000-TON HYDRAULIC FORGING PRESS, ARMOR-PLATE DEPARTMENT OF THE HOMESTEAD STEEL WORKS.

the soldier on the skirmish line a magazine rifle, from which he could fire away all the ammunition which he himself could carry in a very short space of time, unless his ammunition supply can be replenished, and unless he can be taught to use to advantage the ammunition he has. Still, these difficulties of ammunition supply must be overcome, for if one contestant can fire more rapidly than the other he will have a determining advantage, and therefore both will endeavor to be capable of firing as rapidly as may be, and if either side is caught without ammunition, so much the worse for it.

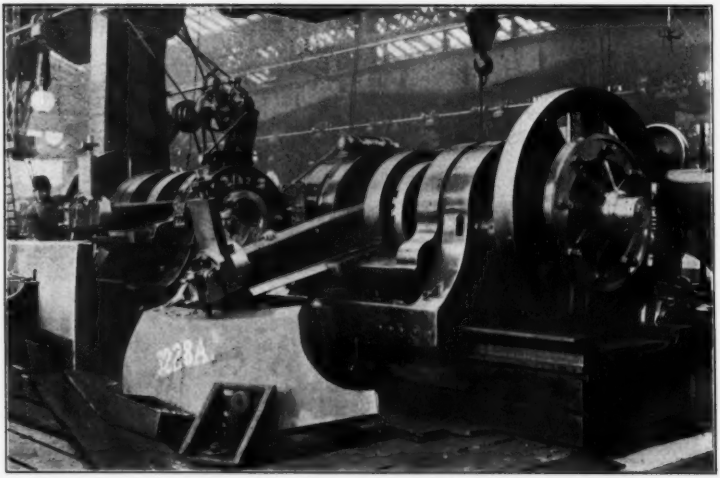
A correct understanding of ordnance engineering may be greatly



INTERIOR VIEW OF ARMOR-PLATE MACHINE SHOP, HOMESTEAD STEEL WORKS.



ARMOR-PLATE ROLLING MILL, HOMESTEAD STEEL WORKS.

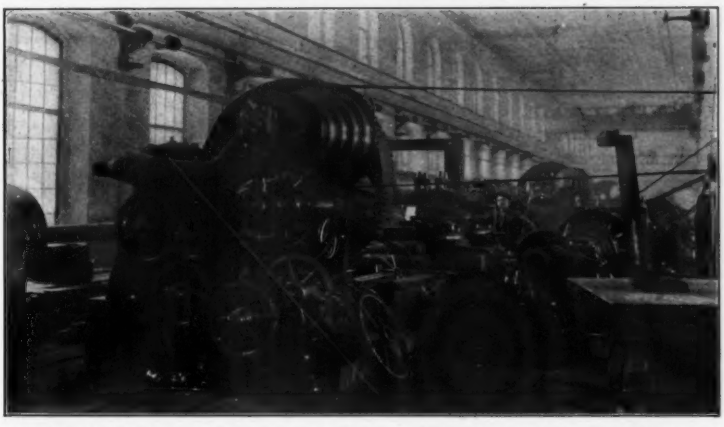


TWO ARMOR PLATES AT THE TWIN SHAPING MACHINE IN THE KRUPP WORKS, ESSEN.
The shaper finishes the edges of armor plates either square or at any desired angle of bevel.

222,300-POUND NICKEL STEEL INGOT FOR TUBE OF 16-INCH RIFLE FOR U. S. ARMY.
Bethlehem Steel Company.

aided by the study of the history of guns and protection. The battle-ship of one hundred years ago—the "line-of-battle-ship" or "seventy-four," as they were called—carried guns which could penetrate

ONE END OF THE ELSWICK SHOP FOR GUNS FROM 6-INCH TO 3-INCH CALIBRE.



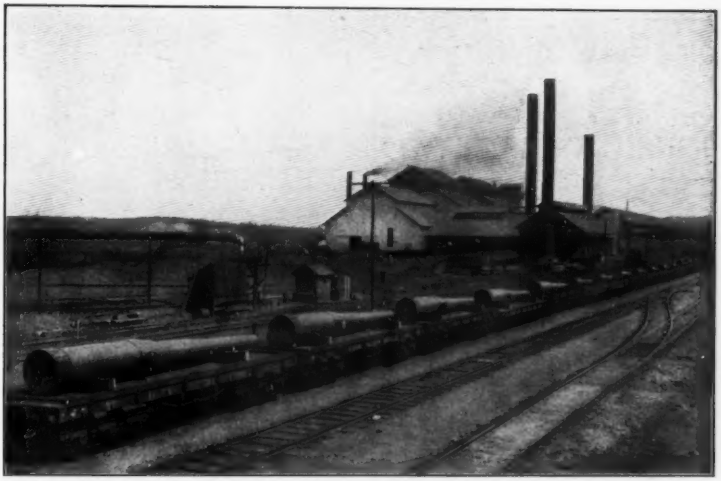
NILES GUN-BORING AND TURNING LATHES IN THE OBOUHOFF WORKS, ST. PETERSBURG.

the sides of similar ships at from 1,000 to 1,500 yards range. Battle-ships of the present day, vessels-of-war of the same class as the old seventy-four, can penetrate their likes at say 2,000 to 2,500 yards range. The old ships fought always much within their effective range.

THE MACHINE SHOPS OF THE ORDNANCE WORKS OF SCHNEIDER & CIE, LE CREUSOT.

and probably the modern ones will do the same. To accomplish anything without exhausting their supply of ammunition they will find that they must do so, because even when the sea is comparatively smooth there will be, in the excitement of battle, many misses. The battle-ship of old fought at about one-third of the effective range of

WORKSHOP FOR LARGE-BORE GUNS AT THE ORDNANCE FACTORIES OF SCHNEIDER & CIE, HAVRE, FRANCE.



TRAINLOAD OF GUNS FOR U. S. ARMY LEAVING BETHLEHEM STEEL WORKS DURING THE SPANISH-AMERICAN WAR.

her guns; at what range will the next great naval action be fought? Those at Yalu, Manila, and Santiago, not being between equally matched ships, hardly give us an answer to this all-important question.

Much has been done in the past twenty-five years to raise ordnance engineering to the rank of a science. Sarrau and Vieille have contributed their excellent works on interior ballistics, and Berthelot and others have investigated the chemistry of explosives, while Rankine, Virgile, and many later authorities have given us mathematical treatises on the strength of guns. The computation of the trajectory of projectiles in air has also been completely worked out. In short, guns and powder can now be made and results predicted in advance in ordnance as well as in any other branch of engineering science.

The strife between the attack and defense—between guns and armor—is always going on. Guns of one day are longer or heavier than those of another, or the reverse, and the weight of armor a ship carries shrinks up into small patches of great thickness, or spreads out over great areas, less well covered. Ordnance engineering follows and appreciates the history and actual condition of these movements, influences them to a considerable degree, and, with the materials and methods in hand, secures the best guns and protection possible.

MINING INDUSTRY AND MINERAL RESOURCES OF BRITISH COLUMBIA.

By Wm. M. Brewer.

In a preceding article, published last month, Mr. Brewer reviewed the mineral deposits of the island regions of British Columbia. The present paper considers the mainland deposits, thus completing a general mineral survey of the province.—The Editors.

IN a preceding article concerned chiefly with the island districts of British Columbia, I referred to some of the conditions which characterise portions of the mainland, especially north of the main line of the Canadian Pacific Railway in that portion known as the Gold Range. But except through a portion of the old Cariboo country, around Atlin and the Porcupine districts, comparatively little is known of the possibilities, geology, or mineral resources of that vast domain which constitutes northern British Columbia.

Along the coast line, where one would naturally look for the greatest developement because of its accessibility, mining operations have been shut down since 1899, when the Dorothy Morton (situated on Phillips Arm about 120 miles northwesterly from Vancouver) was producing an ore which yielded about $10.00 per ton in gold, treated by amalgamation, concentration, and the concentrates by the cyanide process. This district is receiving more attention during the present year, and work is being done on the Blue Bells, a gold-bearing quartz proposition located on Frederick Arm about 4 miles from the Dorothy Morton, also on the Young Australia, a similar proposition joining the Dorothy Morton. In fact, the most extensive developement work so far performed on the Coast has been done at this portion, where a wide zone of schistose rocks occurs containing bodies of quartz. This particular zone is, in my opinion, one of the most promising fields for the operator, because the quartz yields fair values in free gold (the surface sometimes containing as high as $80.00 per ton, but less at

depth), it occurs in extensive bodies, can be mined at a very low cost, and the mineral claims are very easy of access from tide water. The prospecting so far done at deep levels has been confined almost entirely to cross cutting, and but very little drifting along the quartz ledges has been attempted.

Further up the coast, the only other mining districts where any exploitation for lode mines has been carried on are along the Skeena and Nass Rivers, where for the past two years operators have been at work developing bodies of sulphide ores. Near Port Essington on the Oxtail River, a tributary of the Skeena, a syndicate of Victoria men have been developing an extensive deposit of iron pyrites. From this shipments have been made to the Victoria Chemical Works, where the ore is used for the sulphur contents, and the cinder treated to recover the gold values, which have sometimes run as high as 4 ounces of gold to the ton of cinder. The sulphur content of the ore averages about 45 per cent.

Flanking on the northeast side the zone which carries the quartz bodies occurring in the vicinity of Phillips and Frederick Arms, already described, there occurs a zone carrying sulphide ores in which chalcopyrite carrying good copper values predominates, and the country rock is more granitic in character. This zone apparently extends from the southeast and may possibly bear some relationship to the zone of sulphide ores which occurs to the north of the city of Vancouver, and has been exploited to some extent on Theodosia Arm, Jarvis Inlet, and the head of Frederick Arm. At the last named location, considerably more work has been done than elsewhere. The British Columbia Exploring Syndicate have been operating steadily since 1899, and report a large body of ore in sight, but because of lack of transportation facilities to tide water no shipments have been made. However, the management purpose installing an aerial tramway in the future, providing after a more thorough exploitation sufficient ore can be blocked out to warrant the investment. Because of the topography of the country, it was deemed advisable on this property to run a long cross-cut tunnel to intersect the ledge at a deeper level than has been explored anywhere along this zone, and the future of the property depends largely on the results obtained from this work.

The topography of the entire coast line, and usually for some distance inland, is particularly favourable for tunnelling propositions; but past experience has shown that driving cross-cut tunnels, even when deep levels are gained, is a costly and often disappointing experiment in the formations which predominate along the coast, and on the

Pacific Islands especially. It is a practice which has nevertheless been very general amongst the pioneer operators, chiefly for the reason that it is very difficult to transport hoisting and pumping machinery to the altitudes at which most of the outcroppings occur. There is no doubt, though, but that in several cases sinking on the outcrop and following the ore bodies down would have resulted much more satisfactorily.

As THE ENGINEERING MAGAZINE has recently published a brief sketch of the mineral resources north of the main line of the Canadian Pacific Railway,* I shall take up as briefly and comprehensively as possible the present conditions of the mining industry in the southern portion, where lode and dredge mining are the order of the day.

Dredge mining is confined to the Fraser and North Thompson Rivers. Several attempts in the past resulted in failures at various points along the Fraser River. Various causes were assigned for these failures, but none of them were attributed to lack of pay in the beds of these rivers. Faulty construction and bad management were the responsible agencies. There is no disputing the fact that the formation of the river bed of the Fraser was unfamiliar to most of the operators. The immense boulders, cemented gravel, and vertical dip of the schist, slates, and sedimentary rocks composing the formation, rendered it absolutely necessary that the machinery of the dredges should be very heavy and capable of withstanding immense strains. Therefore when some practical dredge miners from New Zealand took hold of the work after thoroughly familiarising themselves with the local conditions, their operations resulted satisfactorily.

Near Lytton on the Fraser River a bucket dredge has been in successful operation about a year. The plant is designed after the most modern New Zealand pattern, very heavy buckets being arranged with chain couplings. This chain of buckets revolves on heavy gearing, so that all the time a certain number of the buckets are travelling up from the river bed loaded, while others are travelling down, after dumping their contents into a revolving screen, and each one takes its turn to scrape the bed rock. By this means, boulders, cemented gravel, and a portion of the bed rock are raised. The boulders and gravel, after being thoroughly washed by a strong stream of water, are discharged from the screen into the river behind the dredge, while the finer material, carrying the gold in dust and nuggets, passes from the meshes in the revolving screen over riffled tables where most of the gold is retained, while the sand is washed into sluice boxes arranged in a line at right angles to the tables. Through these sluice

* See the article by H. Mortimer Lamb, THE ENGINEERING MAGAZINE, July, 1900.

boxes the tailings are washed out into the river, while any fine gold which may have escaped from the tables by passing over with the sand is saved.

At present there is only this one dredge working along this portion of the Fraser River, but another is being worked on the North Thompson, a tributary of the Thompson, which itself empties into the Fraser.

The nearest point to the coast where there is any activity in lode mining is about four miles southwesterly from Kamloops, about 200 miles northeasterly from Vancouver, and at the confluence of the North Thompson and Thompson Rivers. Copper-gold, iron, and cinnabar ores are found in this vicinity, the latter occurring in a northwesterly direction from the town. Although exploited to some extent about 1898, yet since then the mine and retort have been idle. The most extensive developement work which has been done in this immediate vicinity is on the Iron Mask mineral claim, which has been exploited to a depth of about 500 feet. By cross cutting and drifting on the various levels it has been demonstrated that the main ore body has an average width of about 60 feet. The ore carries fair gold values, as well as copper. During the developement several car loads of ore have been shipped to the Trail and Granby smelters, but the English company which owned the property are contemplating the erection of their own smelter in the vicinity of the mine, provided further developement shows sufficient ore in sight to warrant the erection of a smelter of a large capacity.

A cursory examination of the various mineral claims in the neighbourhood shows that there are some unique features connected with the bodies of copper-bearing ore which have been discovered up to the present time. The surface outcroppings cover a zone some twelve or fifteen hundred feet in width, which can be easily traced from point to point for some three or four miles. The outcroppings are usually composed of a heavy bed of washed gravel cemented together and containing copper carbonates, appearing sometimes in crystals of considerable size, at others in smaller particles disseminated through the gravel, and at still other times showing merely stains of copper.

Although so far as known at present the copper-bearing zone is only local in its limits, yet by travelling southeasterly one passes through a country in which deposits of copper-bearing ore have been discovered at several points under very similar conditions to those surrounding the ore bodies in the vicinity of Kamloops. The belt or zone is of variable width, sometimes exceeding a mile, and the points where discoveries have been made are separated from each other us-

ually by several miles. For instance, in the Nicola Valley near the village of Coutlee one finds several discoveries of copper-bearing ore bodies flanked on the northerly side by extensive coal fields; at Aspen Grove occurs another belt of copper-bearing ores and within a few miles a coal field extending from the Tulamene River near Otter Flat towards Granite Creek and the Similkameen River.

Whether a thoroughly systematic geological survey would demonstrate that there exists any relationship between these various discoveries of copper-bearing ore, is a question that can be solved only by such a survey. At a casual glance it would appear as though several isolated areas of copper-bearing ores occurred, but when a more careful study is made of the entire Province, the explorer finds reasons to believe that the mineral-bearing areas do not occur in a haphazard kind of way but follow certain lines of direction approximating to the lines of strike of the country rock, and that although in such zones there are undoubtedly very many barren spaces, yet if the prospector follows out the indicated line, he may yet find ore bodies in many portions which are barren so far as is known at present.

Travelling eastward along the main line of the Canadian Pacific Railway from Kamloops one passes through no metalliferous-mineral-producing areas of any note until the Columbia River is reached. At Revelstoke, where the railroad crosses the river, the traveller finds he is in the centre of a field rich with possibilities and one which merits the earnest attention of the prospector.

Although comparatively little attention has been paid to prospecting from this point, yet there have been found many mineral-bearing claims both to the northward and southward. Most of the prospects heretofore located in the former direction have been in the neighbourhood of the Big Bend of the Columbia River. Such comprise copper-gold bearing ores, some placer gold mines, and an occasional discovery of argentiferous galena. But comparatively little work has been done in this neighbourhood, owing principally to lack of capital and of good wagon roads into the various camps. Pack trails have been used, but the cost for taking in supplies over them is necessarily very high, and that reason alone is sufficient to retard developement work except in a camp where the ore is either free-milling gold or exceptionally high-grade silver or copper.

Travelling eastward along the main line of the Canadian Pacific to the Arrow Lakes, one really commences to enter the chief productive mining districts of the mainland, viz., the West Kootenay, which includes the Lardeau, Slocan, Rossland, and Nelson mining districts.

The Lardeau district, which is entered by steamboat along the northwest arm of Arrow Lake and by a short line of railroad penetrating the district, is the northernmost of these productive mining areas. It is also the most recently discovered—in fact, the first developement of the district commenced as late as 1899. From that time until last year, when the railway was completed, the progress was very slow owing to lack of transportation facilities except by crude trails. The mountain ranges reach a higher altitude than is generally the case, and form the watershed between the Columbia River on the west and the Kootenay on the east. The character of the ore is high-grade argentiferous galena and free-milling gold quartz.

It is difficult to connect the discoveries in this district with any other, but possibly a thoroughly systematic geological survey may determine some relationship between the Lardeau and the Slocan. The ores are quite similar in character, except that in the Slocan, to my knowledge, no gold-bearing quartz has ever been discovered. Now that transportation facilities have been afforded for shipping the ores from the Lardeau, that district ought to develope into as good a poor man's country as did the Slocan. The topography of the two districts is very similar, and because of this topography the miners in the Slocan have been enabled to prosecute their work by tunnelling, either drifting on the ledges or cross cutting and then drifting, thereby avoiding expensive plants for hoisting and pumping. The rich grade of ore in such mines as the Reco, Goodenough, Last Chance, Payne, Slocan Star, Ruth, and others has enabled the operators to haul to the railway sacked ore by means of raw-hiding down the mountains in the winter. With a lower-grade ore such a method of transportation would not have been possible. The same conditions as to grade exist in the Lardeau country; in fact, the ore from some of the Lardeau mines has proved to be a much higer grade than from many of the Slocan mines, which produced during 1901 25,493 tons of ore of gross value $1,865,752. Naturally, since the fall in price of silver and lead, progress in the Slocan has not been as phenomenal as it was from the discovery of the district in 1892 up to 1899; but owing to the fact that several of the mines adopted concentration for their extensive bodies of low-grade ore, the yearly output showed an increase in 1900 and 1901 over the two preceding years. While of course such a showing is very gratifying, yet it would have been more so had there been in addition to this a noticeable enlargement of the territory containing productive mines. The reasons I have given, however, are amply sufficient to account for lack of progress in that direction.

South and east from and adjoining the Slocan district, is situated the Nelson or Kootenay Lake. The northern portion of this district, around Kaslo and Ainsworth, produces ore of a character similar to that of the Slocan, and the first discoveries of this character of ore made in British Columbia were those in the mountains around Kaslo by prospectors who travelled up the Kootenay River from Bonner's Ferry south of the international boundary and prospected along the shores of the Kootenay Lake. The southern portion of the district, in the neighbourhood of Nelson, received its first impetus from the discovery of the Silver King mine, about four miles from the town, producing a gold-silver-copper ore for the reduction of which a local smelter was built in 1896. Until recently, when this mine was closed down, it furnished a considerable quantity of smelting ore, but at the present time the smelter is being run on custom work.

In addition to this character of ore, the Nelson district has received a great deal of merited attention because of the occurrences of free-milling gold ores some few miles from the town on the line of the Nelson and Fort Sheppard railway, a branch of the Great Northern. The Ymir mine is the most extensively developed and has been the most productive of all of these occurrences. It has paid several dividends to date. The underground workings have determined that the ore body maintains continuity to a depth of 1,000 feet. In fact, this is one of the big mines of the province, and if space permitted is deserving of an extended description.

To the southeast of and adjoining the Nelson district is situated the Trail, or, as it is better known, the Rossland. The Le Roi, War Eagle, Centre Star, Iron Mask, and Le Roi No. 2 properties have given this district a world-wide reputation. That these are big mines has been determined by the output and shipments of ore to the smelters; and their developement in future to be bigger mines still is only a question of the successful concentration of the immense bodies of low-grade ores, so that the cost for mining, concentration, freight, and treatment will be brought well within the yield. The Rossland district has had many serious obstacles to contend with since 1899:—First, the excessive prices paid for productive properties, excessive capitalisation, and lack of provision for sufficient working capital to enable the properties to earn dividends proportionate to their capitalisation; second, the labour troubles, which in the first place were directly attributable to the passage of the eight-hour law by the British Columbia Legislature, and demand by the miners for ten-hours pay for eight-hours work; third, the decrease in grade of the ore in the lower levels,

which taken in connection with the fall of the price of copper was sufficiently serious to turn what had been a profit into a loss on the mining, shipment, and treatment of a very large tonnage of ore. But from the latest reports it appears that the Elmore method of concentration, in which oil is used instead of water, is going to prove a solution of the difficulty with which the management have at present to contend. The adoption of this process will mean to Rossland not only the circulation of a great deal of wealth during the construction of the plants, but also a renewal of that prosperity which promised to be permanent a few years back. It will probably mean the resumption of dividends by the Le Roi, War Eagle, and Centre Star mines, and in consequence a greatly increased demand for the stocks at something near their old-time values.

The character of ore which has heretofore been productive in the Rossland district is a pyrrhotite, carrying principally gold values with about 1.5 per cent. in copper; of this the mines receive a very fair proportion from the smelters, instead of the latter deducting 1.3 per cent. —the difference between the wet and dry assay. The Le Roi Company because of owning its own smelter, which is situated at Northport, Washington, a short distance across the line, is of course in a better position to handle a low grade of ore than are the War Eagle and Centre Star Companies, which have to ship their ore to the Trail or some other custom smelter.

From the report of the Minister of Mines for the year ending December 31, 1901, is taken the following information relative to the Le Roi Mine:

Tons of ore shipped (dry) 1901	158,598
Average number of men employed	302
Underground	231
Surface	71

DEVELOPEMENT DURING SAME YEAR.

Shafting	227 feet
Driving	1,517 "
Raising	487 "
Cross cutting	625 "
Winzing	43 "

The value of mining plant, machinery and buildings is $280,890.00."

In the same report appears the following extract from the report made by Mr. R. J. Frecheville, M. I. C. E., to the Directors of the Le Roi Mining Co. and dated Rossland, Dec. 24th, 1901:—

"Mine Workings.

"The mine is opened out by two incline shafts on the middle vein, called the old shaft and the combination shaft. The former, which is down to

the 900-foot level, is situated about 200 feet west of the Centre Star boundary line, and the latter, which has reached the 1,050-level, is 360 feet further west on the strike of the vein, or nearly in the centre of the developed ore shutes. The old shaft has recently been straightened and partially re-timbered at a cost of about $5,500, but is not now used and most probably never will be again. This expenditure might well have been saved. The Combination Shaft is the working shaft of the mine. It is 275 feet long by 6 feet wide in the clear of timbers, and is divided into five compartments. At the 1,050-foot level the station has been cut, but the levels are not yet driven. The 900-foot level is the deepest level in the mine. This shaft has cost in round figures about $100,000. It is a fine piece of work, but is unnecessarily large. The ground proved to be ore-bearing extends from the Centre Star boundary line on the east to the Josie Dyke on the west, a distance of between 1,300 feet and 1,400 feet. At the 500-foot level the combined length of the pay chutes on the middle vein is about 745 feet. On the 600-foot, 700-foot, and 800-foot levels it is about 900 feet for each level. The width of the chutes varies from 6 feet up to 100 feet. On the 900-foot level, which is only partly opened, the pay chute has a length of 170 feet by a width of 24 feet. The general trend of the ore bodies appears to be to the west; thus at the 900-foot level no pay ore has been opened out east of the Combination Shaft. If the present chute now being opened out at this level extends uninterruptedly up to the Josie Dyke, its length cannot exceed 700 feet. This shortening of length is so far compensated by considerably greater average assay value. The western portion of the south vein has been opened by cross cuts from the middle vein at the 500-foot and 700-foot levels, showing a chute of ore about 140 feet long, with an average width of 18 feet. The ore is of lower grade than that of the middle vein."

In summing up, Mr. Frecheville estimates that there were in sight on the date of this report on both veins 604,840 tons of mine ore of an average assay of $10.36 per ton.

The following information relative to the War Eagle Mine is extracted from the report of the General Manager, Mr. E. B. Kirby, dated Jan. 18th, 1902:—

"The closure of the War Eagle Mine by a general labour strike has restricted the mining of the past year to a period of about seven months. This further loss of time leaves us still short of decisive results from the great depth of vein made accessible by the rapid shaft sinking. The shaft, 1,499 feet deep on December 31, will reach the 11th-level point at 1,580 feet by the end of February, and sinking will then be suspended until decisive results are secured from the vein area then accessible.

"The levels are as follows:

6th level	754	feet in depth.
7th "	881	" " "
8th "	1,057	" " "
9th "	1,228	" " "
10th "	1,387	" " "
11th "	1,580	" " "

"The ore shipments for the year amount to 19,864 tons, averaging $15.64 smelter's gross assay value. The average contents were 0.633 oz. gold, 1.08 oz. silver and 2.1 per cent. of copper.

The ore shipments from the Rossland district during the year ending December 31, 1901, are given in the Minister of Mines report as:

Le Roi	158,598 tons
Le Roi No. 2	35,956 "
Rossland Great Western Mines, Ltd.	10,046 "
Centre Star	53,590 "
War Eagle	19,863 "
Iron Mask	4,224 "
Velvet	540 "
Portland	24 "
I. X. L.	188 "
Spitzee	172 "
Evening Star	73 "
Homestake	33 "
Total	283,307 tons
Gross value	$4,621,299

Travelling westward along the Columbia Western branch of the western extension of the Crow's Nest branch of the Canadian Pacific Railway from the Trail mining district, one enters the Boundary Creek district. Until the completion of this line in 1899 this district had made but little progress, but the following list of shipments copied from the Minister of Mines report for the year ending 1901, will show how phenomenal has been its growth since then:

	1900	1901
Old Ironside and Knobhill Group	64,531 tons	231,762 tons
Mother Lode	5,564 "	99,548 "
B. C.	19,618 "	47,517 "
Golden Crown	2,241 "	———
City of Paris	2,000 "	———
Winnipeg	1,076 "	977 "
Snowshoe	267 "	1,731 "
Athelstan	1,200 "	550 "
Carmi	———	885 "
King Soloman	———	850 "
No. 7	———	665 "
R. Bell	———	480 "
Sunset	———	800 "
Jewel	160 "	325 "
Brooklyn	150 "	———
Ruby	———	85 "
Sundry small shipments	1,000 "	500 "
	97,837 tons	386,675 tons

The most noticeable features in the Boundary Creek district, considered in a general way, are:

First, the enormous extent of the surface outcroppings of magnetite carrying chalcopyrite disseminated through the iron ore.

Second, the character of the ore, which is not only self-fluxing but at times rather basic, so that about 5 per cent. of quartz ore can be smelted to advantage with the average ores of the district.

Third, The extremely low cost at which the average ore can be mined and smelted because of the extent of the bodies and character of the ore.

A geological survey of this district was made about two years ago by Mr. R. W. Brock, of the Dominion Geological Survey, who says in the concluding paragraphs of his report:

"Some of the practical deductions from an examination of the ore deposits may be summarised as follows:

"Ores may be found in any of the older rocks where the other conditions for mineralisation were favourable.

Districts which show evidences of late disturbances, through vulcanism, manifested by intrusions of recent eruptives and heavy diking, are promising fields for prospecting.

"Limestone contacts in such areas should in particular be carefully prospected.

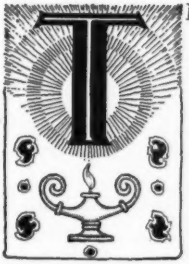
"Since, with the exception of certain deposits in Copper Camp, there is no zone of oxidation and secondary enrichment in the main deposits, while the general conditions remain unchanged, no loss of values is to be expected in depth.

"On account of the irregular form which the ore bodies may possess, and the complex nature of the rock formations, a careful and detailed study of the surface of the ground in the neighbourhood of the mines would be of great practical assistance in the exploitation of the ore bodies. For the same reason developement work must always be kept well ahead of the actual mining. Cross-cutting must frequently be resorted to, to determine the actual limits of the deposit, and to prove the existence or non-existence of parallel ore chutes. The limits of mineralisation must be carefully proved, and similarly that ore can with certainty be reckoned on which has actually been blocked out. In this connection diamond drilling can be used with advantage. Careful magntic surveys would always be of great value in locating ore bodies under the covering of drift, and also for testing for ore in the mines themselves. Especially good results should be obtainable by this method in the magnetic type of deposits, but it should also prove successful in the pyrrhotitic deposits.

"Where the ore occurs at a limestone contact the limestone wall may often be used for following the ore, it being kept in mind that the ore does not always follow strictly along the contact, and that the limestone may pinch out without causing the ore likewise to give out. The dikes in some cases may be used in the same way."

THE LIGHTING OF RAILWAY TRAINS IN EUROPE.

By H. Guérin.



THE progress which has been made in recent years in the lighting of public streets and apartments has naturally had its influence upon the equipment of railway carriages, in which so much has been done of late in other respects to add to the comfort of the occupants. Formerly it was considered sufficient if enough light was provided to permit the traveller to find his way to his place in the compartment, but today the travelling public demands sufficient light to read or work without interruption. If, upon some rare occasion, on certain lines one meets an old-time carriage, he may even today find very rudimentary illuminating appliances, and thus be enabled to realise more fully the progress which has been made by means of the perfected appliances used in the luxurious modern vehicles. The progress in lighting can really be followed distinctly by a general inspection of existing vehicles, since it is impossible to effect a complete substitution at any time, improved methods replacing the older ones gradually as the carriages themselves are worn out and replaced in regular service. At the same time there will be observed a continual attempt to improve the more primitive lighting systems in the older carriages yet in service, so far as this can be done without injury to the structure.

The illumination of a railway carriage is really a complex question, involving the peculiar conditions which belong to its perambulating existence. One must take into account the instability of the air supply, due to the varying speed of the train, the action of the wind, etc., also the limitations of communication between the interior and exterior of the compartments, the necessity for providing for escape of the products of combustion, and for the rapid lighting of the burners. Provision must also be made for the reservoirs for the liquids often employed, and the reservoirs of the lamps must be so placed as to avoid the production of deep shadows in certain parts of the compartment. The transport of illuminating oils also involves a certain degree of danger

from fire, especially in case of collisions or other disasters, this consideration especially demanding the use of simple and strong forms of construction. When the numerous conditions are considered it will be realised that many existing methods of illumination leave much to be desired, as we shall see in the following rapid study of the subject.

Lighting by Candles:—At the present time candles are very seldom used in railway trains in France, not only because of the insufficiency of the illuminating power, but also because of their limited duration and high cost. They are really used only as a temporary resource in emergencies, as we shall observe later on. In other parts of Europe, however, this cannot be said. In Russia, for example, candles are still generally employed on the lines of the interior, the use of petroleum having been attended with but limited success. Candles are also used altogether on the South-Eastern Railway of Prussia, but elsewhere the employment of this primitive means of illuminating is exceptional.

Lighting by Oil Lamps:—The early attempts to use oil employed lamps without chimneys, using flat wicks immersed in reservoirs of oil with variable or constant level. These lamps were inclosed in lanterns built in the roof of the compartments. This arrangement is still continued in many instances, although it involves the inconvenience of requiring the attendant to ascend to the top of the carriage. The feeble light and general smoky condition of these early lamps have led the various railway companies to make efforts to improve them, and ecpecially to effect a better combustion of the oil. The oil itself is required to be pure and free from adulterations and to be quite neutral; it should give a clear, smokeless flame, when burned in a "moderator" lamp, producing an intensity of one carcel (9½ candles) with a consumption of 42 grammes. Improved forms of construction have been devised, the aim of all being to increase the illuminating power by improved combustion, and at the same time to effect better distribution of the light.

On the Western Railway of France a flat-wick lamp without chimney has been adopted, consuming 25 to 30 grammes of oil per hour. This has been replaced on the Northern Railway of France by a larger lamp of similar construction, with the oil reservoir placed above. The reservoir is annular in form, communicating with the burner through two tubes. The annular space is entirely filled with oil, no air being permitted to remain, the burner being fed solely by capillary action. The space between the annular reservoir and the burner is occupied by a reflector; there is an opening in the centre communicating with a sheet-metal chimney forming a part of the lantern surmounting the lamp, which provides for the discharge of the products of combustion.

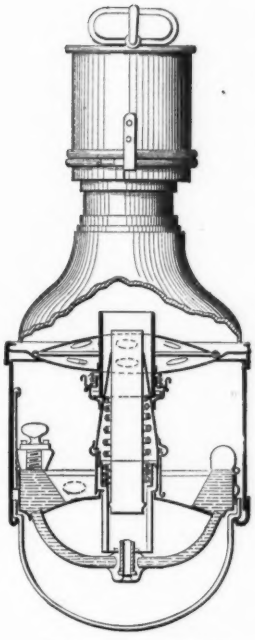


FIG. I. FAUCON LAMP.

The cap of the lantern is formed of several cylinders, pierced with holes, these serving to check the force of the wind produced by the motion of the train and prevent it from blowing out the flame. The whole lamp is enclosed in a glass cup, preventing all communication with the interior of the carriage, this cup also receiving any drops of oil which may be accidentally spilled. This lamp gives a strong light, but is liable to smoke, and possesses the disadvantage of being fixed to the carriage.

Experience, confirmed by numerous tests, shows that with flat-wick lamps there will always be an incomplete combustion and imperfect illumination. This has led various companies to adopt cylindrical burners. Thus the Eastern Railway of France has used the *"Faucon"* lamp with a cylindrical wick and central draught, consuming 20 grammes of oil per hour and operating for 13 consecutive hours without attention; the illuminating power is 5 to 6 candles, or in the latest forms, 8 candles, with a consumption of 35 grammes of oil. The general arrangement is shown in Figure 1. The annular oil reservoir is retained, but a cylindrical wick replaces the flat one, the holder being provided with a central opening to permit the air to reach the flame. The burner is arranged to hold a glass chimney extending up into the metal chimney of the lantern. This type is also used on the Paris-Lyons-Mediterranean Railway, and on the State Railway of France.

The Northern Railway of France also employs in its first-class carriages an oil lamp with cylindrical wick. This lamp, of which the arrangement is shown in Figure 2, gives a brilliant and agreeable light, but is rather delicate as regards care and manipulation. The general arrangement of the parts resembles the Faucon lamp; the intensity of the light is 0.7 carcel (about 6¾ candle power) and the consumption 32 grammes of oil per hour. The upper reservoir, constructed on the principle of Mariotte's vase, maintains a constant level of the oil. A glass chimney is provided, prolonged by one of sheet metal of conical

form to increase the intensity of the draught. The body of the lantern is pierced with holes to permit the entrance of the air for combustion, while the upper cylindrical portion is made removable for convenience in cleaning. The principal objection to this lamp lies in the fact that each time it is attended to it must be entirely emptied and refilled with fresh clean oil; this, however, can be satisfactorily effected by means of a special form of suction oil pump. The silvered reflector is formed with especial reference to the distribution of the light over the interior of the compartment without the production of dense shadows from the feed pipes.

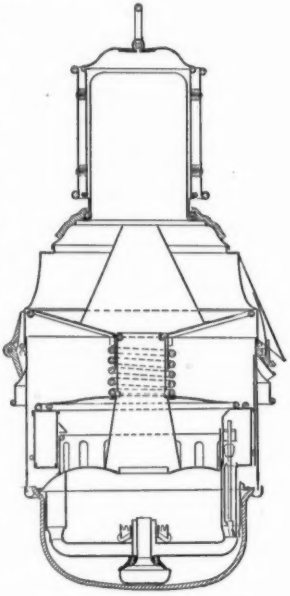


FIG. 2. OIL LAMP WITH CYLINDRICAL WICK.

The preparation of the cylindrical-wick lamp requires some time and proper facilities, and hence it is generally done in a special department. When ready for service, each lamp with its lantern is placed in a compartment of a special wagon, as shown in Figure 5. This wagon is drawn out to the platform and one attendant mounts upon the roof of the carriage while another passes the lamps up by means of a special hook. The fresh lamps are thus rapidly substituted for the empty ones, and these latter are drawn away in the wagon to the lamp room at the station. Various forms of lamps with cylindrical wicks are employed on the railways of other countries, one example being the Lafaurie & Potel lamp, shown in Figure 3, this also being used on the Western Railway of France. In this form the oil is maintained at a constant level in a vessel closed by a screw stopper, this latter being placed in the lower part to avoid possible entrance of air. The supply of air for the outside of the wick is produced by the draught of a metallic chimney supported by the reflector. The air for the interior of the flame is delivered through a lateral tube, parallel to the oil-feed tube, both draughts delivering up into the hood of the lantern; the glass chimney of the previous forms of lamp is thus omitted. This lamp gives a steady white flame with a consumption of 25 to 30 grammes of oil per hour and a duration of 16 hours.

In Austria, Hungary, and Roumania the railways use oil lamps with cylindrical wicks and glass chimneys. In Alsace-Lorraine Argand lamps are used, and in Baden single-burner lamps are employed. These latter lamps are arranged to be regulated by a rack and pinion, while the Lafaurie & Potel lamps, as well as the Faucon, and the type of the Northern Railway of France, have no means of regulation, the height of the flame being determined by the fixed height of the wick when the lamp is placed in position.

The number of lamps used to a carriage is variable. In France it is customary to use as many lamps as there are compartments. Some carriages are provided with but one lamp to two compartments. On the Kaiser Ferdinands Nordbahn, in Austria, in the third-class carriages, there are but one or two lamps used for three compartments.

Advantages and Disadvantages of Oil Lamps:—The advantages of oil lamps may be summed up as follows:—They produce a clear, steady light, free from serious danger of fire or explosions; they are not liable to general interruption, owing to their independence of one another, in contrast to electricity or gas; the apparatus is light, and the first cost moderate.

The disadvantages may be likewise enumerated:—Their action is liable to interruption in cold weather, requiring the reservoirs to be warmed; this may be avoided by the addition of petrole to the oil, but this again renders the lamps liable to smoke, besides conducing to explosions and fires. If the lamps are not well cared for the entrance of air is apt to cause irregular action, besides which the wicks become charred; hence a fair degree of skill is necessary for attendance. A certain amount of expense is also incurred in the breakage of glass chimneys and cups, so that when these points are taken into account it will be seen that this system of lighting is not very economical.

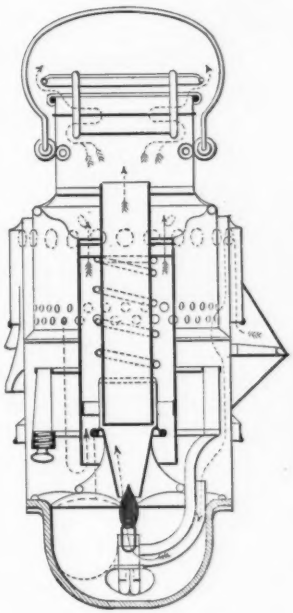


FIG. 3. OIL LAMP, LAFAURIE & POTEL SYSTEM.

Lighting with Mineral Oils:—Experiments in the use of petroleum for

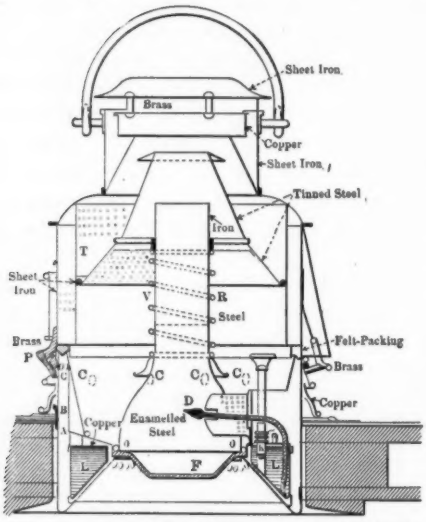


FIG. 4. MINERAL OIL LAMP, SHALLIS & MOURAS SYSTEM.

lighting have been made by the Northern and Western Railways of France, and while these have given interesting results the use has been discontinued as being too costly and dangerous. The Orléans Railway alone continues to use this system for first-class carriages, employing the Shallis and Mouras lamp, Figure 4. This apparatus may be divided into two portions, the lantern and the lamp properly so-called. The external appearance differs but slightly from the oil lamps already described. The external air enters the lantern through small holes in the lower part of the body in such a manner as to circulate about the oil reservoir. The upper cylindrical body of the lantern is also pierced with holes permitting the entrance of air to aid in the combustion. The lamp itself consists of a reservoir L, for the mineral oil, a double envelope, and a combustion chamber, D. The reservoir, made of tinned steel, contains about ½ litre, and is made without any seams below the level of the oil. The double envelope which separates the combustion chamber from the reservoir forms the reflector, E, shaped like a truncated cone to which is attached a cup-shaped partition. The rim of the base of the upper portion is provided with a packing of felt fitting against the top of the double envelope of the lamp, thus effectually preventing any communication between the upper part of the lantern and the portion containing the oil reservoir. When the lamp is lighted the air within the carriage is drawn through the openings in the conical reflector, circulates in the double envelope heated by the flame of the lamp, and escapes through the openings in the lower portion of the lantern. This circulation is intended to cool the reservoir containing the oil. The combustion chamber is closed by a bell of enamelled steel placed above a glass cup, F, and supporting the lower part of a spring

chimney holder. The air required to maintain combustion is admitted through holes in the lower part of the bell, and is heated by contact with the envelopes of the lantern. The burner, G, is soldered hermetically to the double envelope, and is connected at its extremity with a tube admitting fresh air. The wick is regulated by a thumb button or by a removable key. The arrangement of the parts is such that the oil may be spilled without possibility of its ignition; the reservoir communicates with the external air by means of tubes, so that if the lamp is overturned in case of accident, the oil can escape without coming in contact with the flame. The intensity of this lamp is 1½ carcels (about 14 candle power) and its duration is from 12 to 14 hours. The density of the oil employed is 0.826 at 16° C., and it ignites at a temperature of 126° C.

This system of lighting has been used in various countries. In Bavaria and in Würtemburg various forms are used, with flat and with cylindrical burners. On the Hungarian railways the ordinary ceiling lamp is used in a modified form, with flat horizontal burners. The

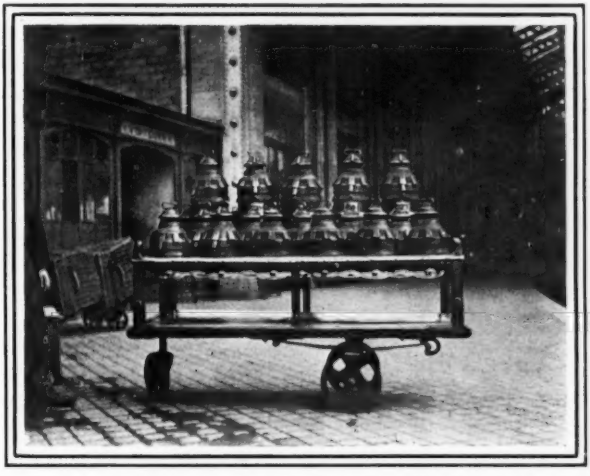


FIG. 5. CAR FOR TRANSFERRING OIL LAMPS, NORTHERN RAILWAY OF FRANCE.

system, however, is far from being generally used. This is due to the great danger which attaches to the use of petroleum, notwithstanding the precautions which may be taken, since these may be rendered ineffective by the neglect of the attendants.

Lighting with Oil Gas or Enriched Gas:—The first attempts to use

gas for train lighting were made with compressed coal gas. Experience showed that the compression caused the gas to lose about one-third of its illuminating power. It was therefore sought to carburet the ordinary coal gas to enrich it. For this purpose the Western Railway of France has used a special lamp, Figure 6, containing a brass reservoir filled with fragments of of naphthaline. A small tube passes from this reservoir into the chimney of the lamp, where it is heated by the gases of combustion. The naphthaline in this tube becomes vapourised, while that in the reservoir is reduced to a liquid condition, and passes in turn to the vapourising tube. The gas, passing through an adjoining tube, mixes with the vapour of naphthaline, and is consumed in a goose-neck burner. This system, however, is liable to interruptions by the choking of the burner with naphthaline, and it has not been found satisfactory in practice. A more successful scheme has been to use the compressed air from the Westinghouse brake reservoirs, carburetted with gasoline.

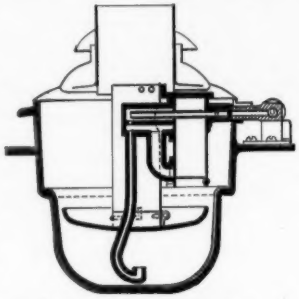


FIG. 6. LAMP FOR CARBURETTED GAS.

The most general method, however, is the use of compressed oil gas. This gas is either carried in special tank cars attached to each train, or else in smaller reservoirs attached to each carriage. The first method has been adopted in Belgium and in France; it is more economical than the second, but it involves the necessity of connecting the gas tank with a piping system extending through the entire length of the train, this involving a liability to serious leaks. Since 1881 the Western Railway of France has adopted the plan of placing separate reservoirs under the various carriages. The Paris-Lyons-Mediterranean Company also uses separate reservoirs, but places them on the tops of the carriages (Figure 7). Oil gas is produced by the distillation of bituminous schists, petroleum residues, and heavy mineral oils. Its illuminating power is 3.5 to 4 times that of ordinary coal gas. Thus a light of 6 candle power is obtained by an hourly consumption of 22 litres of gas, compressed to 10 kilogrammes per square centimetre, and released under a pressure of 10 millimetres of water.

This system includes an arrangement of piping under the platforms at the terminal stations, these connecting with storage reservoirs at the compressing stations, and enabling the reservoirs under the carriages to be charged promptly. Each carriage is provided with one

FIG. 7. CARRIAGE ON THE PARIS-LYONS-MEDITERRANEAN RAILWAY WITH GAS RESERVOIR ON THE ROOF.

or more tanks, holding sufficient gas to insure illumination for 16 hours at full brilliancy, the quantity of gas in the tanks being indicated by pressure gauges. The normal pressure is maintained at the burners by means of automatic regulators. The lamp is provided with a reflector of enamelled iron, placed above the burner, there being an opening fitted with a chimney for the escape of the products of combustion. The burner itself is separated from the interior of the compartment by a glass cup, similar to that used for oil lamps. In common with any system of gas lighting, the burners may be lighted in all or any of the compartments, or they may be controlled from one point only for the entire carriage. The usual practice is to have the lights controlled by the conductor, by means of a special key. They may also be provided with keys in each compartment, by which the travellers themselves may extinguish the light, or the gas may be turned off automatically by the closing of the screen provided to cover the lamp. This latter method is of interest, since by its use an economy of gas of 25 per cent. may be secured. In France the cost of a cubic metre of gas, including interest and depreciation on plant, is from 0.50 to 0.80 franc; in Belgium it is only 0.37 franc, and in Germany it is 0.57 franc.

Train lighting by oil gas has been used with success in Alsace-Lorraine, in Bavaria, in Austria, in Holland, in Switzerland, and in Bel-

gium. It has been introduced gradually, but none of the railways which have introduced it seems disposed to abandon it. Its advantages appear in its cleanliness, the uniformity of the light, and the small amount of attention required. At the same time its use involves a certain degree of danger from explosions, and the cost of the installation, including the equipment of trains, stations, and apparatus, is considerable.

Lighting by Acetylene:—The lighting of railway trains by oil gas has been notably improved by the admixture with the gas of a certain proportion of acetylene. This idea was first employed on the Prussian State Railways, where it was found that the mixed gases gave a far superior light to that of the oil gas alone. In France this system has been taken up by the Paris-Lyons-Mediterranean Railway, and a generating plant is being installed adjoining that already in use for the production of oil gas. This station includes a storage department for the calcium carbide, which is kept in metal casks, handled by a swinging crane; also a second building in which the gas is generated. The generator is of the Pintsch system, in which the carbide is dropped into a large volume of water. The apparatus consists of a cylindrical vessel of galvanised iron filled to about three-quarters of its height with water, the top being closed and carrying a cast-iron chest containing the mechanism for feeding the carbide. This chest contains two compartments, each holding about 2 kilogrammes of carbide, and arranged in such a manner that either of them may be placed in communication with the main cylinder without permitting the escape of gas. The acetylene gas, disengaged by the contact of the carbide with the water, is led off through a lateral pipe connecting with the mains. The lime produced by the decomposition of the carbide is received upon an iron grating which can be tipped from time to time, and the residue removed through an opening at the bottom. The water level is regulated by a siphon, this also forming a safety valve. The ammoniacal water, impregnated with lime, is regularly removed by means of a Worthington pump. The gas is washed and purified from the ammonia and moisture which it contains by means of chloride of calcium. This apparatus has a capacity of 500 cubic metres of acetylene in 24 hours. The oil gas and the acetylene are passed though respective meters, these being connected by chain gear, the sprocket wheels being arranged so that the mixture of the gases is made in the ratio of 3 of oil to 1 of acetylene.

The mixed gas is supplied to the carriages in the proportion of 1,500 cubic metres of oil gas to 500 cubic metres of acetylene. The illuminating power is maintained at 12 candle power with a consump-

tion of 25 litres of gas per hour. While good results have been obtained by the use of acetylene, it has as yet not been given a sufficient trial to determine its entire availability for train lighting.

Lighting by Electricity:—The electric lighting of railway carriages has been effected in three different manners:

1. By a dynamo driven by an engine receiving its steam from the boiler of the locomotive.

2. By a dynamo driven from the axle of the carriage, and operating in connection with a storage battery.

3. By accumulators charged at the terminal stations.

In the first system the dynamo and its engine are placed on the tender of the locomotive, the steam supply being regulated by a valve in the control of the engineer. This plan, which has been tried in England, has the inconvenience of depriving the carriages of light when the locomotive is disconnected from the train. Every time the engine is changed the illumination of the train is interrupted.

In the second system each carriage carries its own dynamo, driven by means of a belt from one of the axles, this charging a storage battery. This requires the introduction of mechanism to render the direction of the current independent of the direction of the motion of the train, and also to prevent the connection of the dynamo to the battery until the velocity of the motion renders the pressure of the current equal to the tension at the terminals of the battery. The intensity of the current generated by the dynamo assures the maintenance of a supply for the lamps, and the charge of the battery remains nearly uniform, whatever the speed of the train, by reason of the slipping of the belt when the resistance increases. A uniform tension is maintained upon the belt by the weight of the dynamo, partly relieved by a counterbalance. This arrangement, known as the Stone system, has been used in England, and also in the carriages of the Compagnie des Wagons Lits, and on the Paris-Lyons-Mediterranean.

The Western, Eastern, and Central Railways of France, and also the State Railway, have used the Vicarino system, the dynamo being driven from the axle by a friction gear, and operated in connection with a storage battery and make-and-break switch. The dynamo is arranged with a compound winding which provides a uniform voltage regardless of the speed of the train. When the speed attains 600 turns per minute the switch throws the current from the dynamo into the storage battery. The pressure employed is 30 volts, and the power absorbed by the dynamo is about 1½ horse power, the lamps being of 8 candle power.

In another system, used by the Paris-Lyons-Mediterranean Railway, the dynamo is also driven by belt connection with the axle of the carriage. A storage battery maintains the illumination of the lamps when the speed falls. If, on the contrary, the speed is increased, the switch throws the two sources of electricity in parallel. The intensity of the main current is maintained constant by means of a small motor operated by the excess energy of the dynamo, this creating a resistance which increases with the velocity. An automatic reverser renders the direction of the current constant, independently of the direction of movement of the carriage.

The third system has been employed by the Northern Railway of France, using accumulators contained in cases attached to the framework of the carriages. Each carriage is provided with four cases of accumulators. Hinged doors permit access to the batteries from without, openings in the sides of the cases permitting the escape of the gas. The batteries consist of elements contained in ebonite cells, placed in pairs in lead-lined iron baskets, insulated on glass plates. four of these pairs being in each case. Each element is composed of six positive and seven negative plates, the current being taken off by metallic spring clamps. The connections are made automatically by cables carrying metallic tongues at the ends inserted between the spring clamps. There are 60 elements to a carriage, arranged in two batteries of 30 elements each, there being 28 in regular service and 2 held in reserve. The two batteries are connected in parallel, both in charging and discharging. The plates weigh 1,100 grammes, or 14 kilogrammes per element; their minimum capacity is 10 ampere-hours per kilogramme of active material. The minimum capacity of one battery is therefore $14 \times 10 = 140$ ampere hours. In the interior of each carriage the switches are placed, these being arranged to give three connections, placing 28, 29, or 30 elements in the circuit (Figure 8), each switch being conected to one battery of 30 elements. After passing a safety fuse the current is divided into two circuits, Nos. 1 and 2, controlled by two switches placed in the corridor of the carriage. There are two lamps in each compartment, one fed by circuit No. 1, and one by circuit No. 2. The same arrangement is followed for the lamps in the corridor, one half being independent of the other half. The lamps are generally run at a pressure of 55 volts, with an illuminating power of 6 candles. These lamps are placed in the ceilings of the corridors and platforms, while in the compartments they are attached to the extremities of curved arms. The ends of the lamp bulbs in the compartments are obscured, to prevent the light

from inconveniencing the occupants of the opposite seats. The arrangement of the wiring is shown in Figure 9, the wires being conveniently placed in channels behind the mouldings. The accumulators, of the Laurent-Lély type, are charged in the cases, before the departure of the train, by means of conductors arranged on the platform and connected to the electrical station. Here the alternating current originally generated at a pressure of 6,000 volts is transformed to a continuous current of 300 volts by means of the converters and transformers shown in Figure 10.

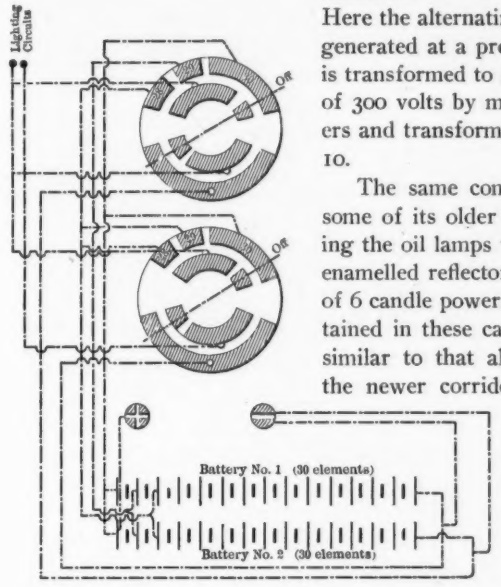


FIG. 8. WIRING SYSTEM, USING ACCUMULATORS.

The same company has improved some of its older carriages by replacing the oil lamps with lanterns having enamelled reflectors and electric lamps of 6 candle power. The current is obtained in these carriages in a manner similar to that already described for the newer corridor carriages, except that the storage batteries contain but sixteen elements in place of thirty.

Another system of train lighting by electricity, similar to that used in France, is found on the Jura-Simplon Railway, in Switzerland. The accumulators employed are of the Huber system, arranged in batteries of nine elements arranged in series. The plates are composed of non-oxidisable gratings of an alloy

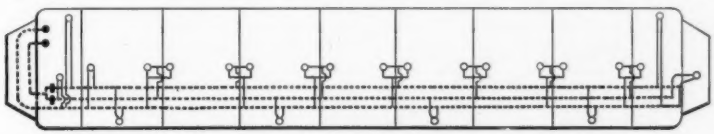


FIG. 9. CAR WIRING, NORTHERN RAILWAY OF FRANCE.

of lead and antimony, the cells of the positive plates being filled with minium and those of the negative plates with litharge. The electromotive force of a single element is 2 volts, or 18

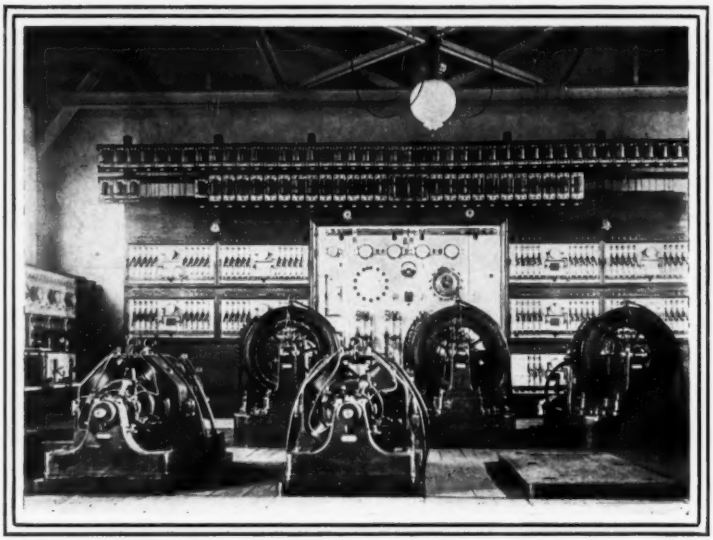


FIG. 10. TRANSFORMING STATION FOR ELECTRIC TRAIN-LIGHTING SERVICE, CHEMIN DE FER DU NORD.

volts for the series, the capacity being 120 ampere hours. The distinguishing feature of the system is found in the method of charging the batteries. On the Jura-Simplon Railway there are a number of stations at which accumulators are brought to the platform and substituted for those which have become exhausted on the trains. All the exhausted batteries are placed on a truck and taken to the distributing car. This car is devoted entirely to delivering charged batteries to the various stations and returning the exhausted ones. The charging is effected at a central station by a dynamo operated by a Thury motor of 35 horse power, itself driven by a current of 300 volts taken from the supply of the town. The accumulators are charged in series of five batteries, the initial tension being 90 volts, rising towards the close of the operation to 112 volts. The normal charging current is 18 amperes.

In Switzerland the cost of electric lighting is very moderate, owing to the favourable conditions for the production of electricity. Boilers and engines are entirely dispensed with, the energy being supplied altogether from the mountain streams, and the cost of current is only about 0.08 franc per kilowatt-hour.

MONEY-MAKING MANAGEMENT FOR WORK-SHOP AND FACTORY.

By Charles U. Carpenter.

VIII.—THE FINDING AND RECORDING OF COSTS.

In the following paper Mr. Carpenter concludes his series, begun in February, 1902, and interrupted last month only by the author's serious illness. His first and second articles dealt with factory organization in its general principles and concrete examples, the third with departmentalization and systematization of the works, the fourth and fifth with the stock department, the sixth with machining processes and tool equipment, and the seventh with piece work and the fixing of prices. The whole series forms a consistent exhibition of a policy of management which has proved wonderfully successful in actual practice.—THE EDITORS.

MODERN commercialism not only demands the finest machinery and the most capable men working at the highest possible pitch, but also renders it imperative that all component parts be knit together by modern methods of organization, and that product, processes, departments, and men be checked up and their efficiency gauged by the most thorough methods of accounting and system.

How often has it occurred that a firm, prosperous in the early days of its existence, failed utterly after it had grown to such size as to make it impossible for the heads to retain that "personal touch" with details. The need of something to take the place of this personal touch is imperative and increases as the concern grows larger. The modern factory manager or superintendent must retain that vital touch with the internal working of his organization in this day of close competition, small profits, and intense activity of production. And yet, how many managers can distinguish the inefficient parts from the strong portions, and assign unerringly the cause for such inefficiency, thus being enabled to throw all of their power, knowledge, and experience toward the strengthening of such weak points? Can they state positively whether or not each department is being operated as economically or as efficiently as it should be? Can they detect immediately any increase in expense or deterioration in working efficiency in any of these departments? Are the costs calculated upon a correct basis, and are they compiled in such a manner as to show in detail any increases and, as well, render it possible to make intelligent examinations and comparisons with a view to the effecting of economies? In short, can the man-

agers feel and judge of the pulse of their organization? Are they in such control of their mighty engine of production that they can detect, correct, and improve its weakest points and keep the entire machine keyed up to its highest pitch of efficient productiveness?

A flexible homogeneous system of factory accounting must be devised in such a manner as not only to show the costs of the product, but also to give unerring indications of the exact working conditions and efficiency of all departments in factory and office. The factory manager must have some means whereby he can check large unnecessary expenditures or heavy losses. He should be able to detect any increases in cost above normal, or any unnecessary investments in stock for manufacture. He should know not only the details of all gains and losses on the various products, but also the state of working efficiency of every department in the organization. This article will deal with a few of the important features of this subject. Owing to the fact that most of the data desired can be secured from properly devised cost records, consideration will first be given to the subject of "costs."

The necessity for accurate cost systems has been brought out so clearly in this Magazine by A. Hamilton Church, J. Slater Lewis, Henry Roland, Hugo Diemer, H. L. Arnold, J. N. Gunn, and others that it is unnecessary to dwell upon this feature of the question.*

Where does Profit End and Loss Begin?—The all-important question for every manager to ask himself is "Do I know positively at what figure my profit ends and my loss begins on each one of my products?" The commercial success of a business often depends upon the answer, and that answer is found in the solution of the problems of cost accounting, which may be thus classified:—

I.—The collection of data for the compilation of prime costs, *i. e.*, labor and material.

(a) The devising of forms, cards, tickets, etc., by means of which the data can be collected.

(b) The institution of methods for securing these data from the shop and of enforcing accuracy.

(c) Consideration of the various uses to be made of these data—"Workman's Time and Earnings Record," "Job Time and Wage Classifications," "Efficiency Reports," etc.

(d) Balancing of expenditures for labor and material with cost records.

II.—The collection and proper distribution of those items other

* See THE ENGINEERING MAGAZINE, Oct., '97—Jan., '98; Apr.—Nov., '98; Oct., '99—May, '00; June—Nov., '00; Jan., '01; July—Nov., '01.

than labor and material which cannot be charged directly against the jobs, but which should be charged against factory production, *e. g.*, general factory and departmental supervision, clerks, expense of non-productive departments, interest on investment, etc. These may be termed the Factory General Charges.

III.—The collection and proper distribution of those items coming directly under the commercial end of the business, *e. g.*, salaries of officers, selling, advertising, legal, patents, etc. These may be termed the Commercial General Charges.

IV.—The collection and apportionment of these several charges unto the proper ledger accounts.

In view of the former articles appearing in this Magazine it is unnecessary to present any comprehensive discussion upon the question of costs. The most difficult problem to solve is the method of distributing the general charges. A system involving simple processes may, when carefully worked out, prove satisfactory provided the products and manufacturing processes are of a simple character, and the cost of production and necessary investments for machinery, etc., for these products do not differ largely. The case is entirely different where there is a large difference in the proportional expenditures for supervision, machinery, floor space, advertising, selling, etc. Certain it is that this difference must be considered when the system is devised.

Mr. Church's New Machine Rate.—Mr. Hamilton Church has presented a full and able discussion upon the defects of the ordinary "percentage-on-wages," "hourly-burden" and old "machine-rate" plans.* He proposes one of the most thorough and exact systems of distribution yet presented. His inclusion of the general charges in the "machine rate" and the further distribution of his "supplementary rate" disposes of this question with precision. His supplementary rate provides a valuable index of the working efficiency of machinery. It will be noted that this plan of distribution can be worked very simply into the plan of collecting cost data presented here.

Departmental Charges.—Whatever general plan of distribution be adopted, the general factory charges should be divided into departmental charges as far as possible. Each department is thus charged with its proportionate share of expense of general and departmental supervision, interest on investment, floor space, heat, power, light, etc. This total is then distributed over the work done in that department. In cases where there is a line of demarcation between the different products and the machinery, floor space, and power necessary for their

* See THE ENGINEERING MAGAZINE, July—November, 1901.

production, it is possible to divide these departmental charges further so that each type of product will bear a part of each departmental charge, in proportion to the expense for machinery, floor space, power, etc., for which it is responsible.

Collection of Cost Data.—The system presented for the collection of prime-cost data is but one of many effective ones. This, however, presents some distinctive features which prove to be of great value in many directions distinct from the cost system.

NAME..... CHECK NO..... DEPT. .....

Date	Name of Part	Operation	Quantity	Rate	Classification																
					Type A			Type B			Type C			Type D			Type E				
					Time	$	Cts.	Time	$	Cts.	Time	$	Cts.	Time	$	Cts.	Time	$	Cts.		

Totals .....

Total Time.....

Total Earnings.....

Total Day-work Hours.....

Total Piece-work Hours.....

Average Piece-work Earnings.....

Day-work in Red ink.....

DAY-WORK AND PIECE-WORK RECORD CARD.

The ordinary system involves the use of time tickets and the entering of the data thereon, together with the material costs, in prime-cost books or cards. All material and labor entries go under the proper order numbers. Total or detailed costs of any order can be thus secured. The time tickets shown here are of ordinary form. The stock-tracing and cost cards are distinctive, and take the place of the prime-cost books or cards. In addition they fulfill other very valuable functions. All necessary data for compilation of prime costs and other records are secured from these time tickets and stock-tracing and cost cards.

Time Ticket.—A time ticket should contain all order, job, and

machine numbers, names of department, foreman, workman, inspector, and stock tracer; number of parts finished by workman and number accepted by inspector; piece price or day-work rate, total time consumed, and total earnings. These tickets should be in duplicate.

Course that time tickets should take:—

1.—Made out and signed by workman.

2.—Signed by foreman.

3.—Sent to stock tracer, who enters up data upon corresponding stock-tracing and cost card and OK's ticket. This prevents duplication of tickets and makes it possible for these cards to serve as both cost and stock-tracing records.

4.—Turned over to inspector, who OK's ticket for accuracy of record, workmanship and amount.

5.—Original sent to cost clerk and duplicate to original workman.

Stock-Tracing and Cost Cards.—These cards should contain works and job-order numbers, name or number of part to be manufactured, kind, amount, and cost of raw material delivered, box numbers, and date work should be completed. The headings of the several columns show clearly the nature of the data required, including complete detailed cost, time, losses and machine number records, etc. The manner in which these data are secured has been explained in article on stock tracing.* Most of them are secured from the time ticket. Each part or number of similar parts necessary for each order should have its own card. All cards for parts belonging to one order should be kept together on the file.

Completion of Order.—As soon as the parts are finished and delivered as "finished stock," the cards for these parts, after being OK'd by stock tracer and stock keeper, are sent to the cost clerk.

The Requisition (see article on "Stock"*).—As all requisitions for stock necessary, for instance in assembling, must bear the proper order number and are sent direct to the cost clerk after being OK'd by stock clerk, they, together with the stock-tracing and cost cards bearing the same order number form a complete record of the material and labor costs of any order. Thus complete or partial costs can be secured at any time. These cards furnish also a series of records for analyses for estimating on new work; a perfect stock-tracing and time record; a complete history of all delays and losses; an effective bar to cheating; and a full and accurate inventory of all stock in course of manufacture. If it is desirable to extend all costs, the data on the cards and requisitions can easily be extended and results compiled upon special cards.

* THE ENGINEERING MAGAZINE, May and June, 1902.

These cards will contain the totals of materials and labor contained on each stock-tracing and cost card and requisition and, finally, the totals of all of these items.

Apportionment of Factory and Commercial General Charges.—This subject has already received such thorough treatment by previous writers for this Magazine that no further elaboration is needed.

Workman's Time and Earnings Card.—In the article on systems of pay was described the manner in which the time tickets, after being turned over to the cost clerk, are first assorted according to workman's name. The data thereon are transferred to the workman's time and earnings card. This card is so arranged as to provide a classification of time and earnings according to the type of product worked upon, the day-work time and earnings being entered in red ink, so as to differentiate them from the piece-work time and earnings. Each man's time must be checked against his time shown by the time clock or time book. Provision is made for totals of day-work and piece-work time and earnings, and the percentage of piece work to total time. These cards should be grouped by departments. From these cards we secure: 1, Total factory and departmental pay-roll; 2, total hours worked; 3, total time and earnings on each type of machine; 4, piece-work and day-work hours and earnings, and the percentage that the

Name Part_____ Standard Time for Job_____

Job No._____ Operation_____ Department_____

Date	Name of Workman	No. parts Finished	P.W. Price or Day Rate	Time		Earnings			Indicate clearly any variations from Standard Time and send to Supt. at once
				Total	Per part	Total	Per part	Area per hour	
N.B. All Day Work records to be in red ink									

JOB-PRICE AND EARNINGS RECORD.

piece-work hours and earnings bear to the totals; 5, average rate per hour, piece-work and day-work. All these data are departmental.

Job-Time and Earnings Card.—The workman's time ticket should next be classified by jobs and entries made as shown. An examination of this record renders its importance clear. The entries thereon will prove very instructive. It serves as the medium whereby any in-

crease in labor costs on any job is immediately noted. I have already treated of the advisability of settling by calculation, investigation, or careful trial, the actual time in which each job could and should be done by the workmen.* This "standard time" per piece or per one hundred pieces should be put upon this job card. The entries should be kept up to date, and when any serious variation from standard time appears the cards should be sent to the superintendent for investigation. This should invariably be searching and thorough. Both foremen and workmen should understand that they will always be called to account for any serious variations from this standard time. If a workman's record shows badly in this particular, he should be dropped. This is a most effective method of comparing the capabilities of the workmen and of singling out the ones who should be discharged. Any tactics in the line of favoring an inefficient workman will fail before such a method. In many cases it will be found profitable to pay premiums to both men and foremen when a department proves to be especially efficient in this particular. This system is valuable whatever system of pay is used. The "earnings per hour" will often reveal an important story. These data will indicate when the job should be investigated and prove invaluable in cases where yearly adjustments of piece rates are made, especially when dealing with the union.

Balancing of Expenditures for Labor and Materials with Cost Record.—The limits of this article will not permit of any lengthy consideration of this subject. Ordinarily all costs are extended and totals of materials checked against stock records, and totals of labor against wages account. The values of stock in the stock room can be secured by means of a proper stock account showing debits and credits for receipts and deliveries. The manufacturing account will in like manner indicate the value of stock in course of manufacture. With the use of a proper stock-card system, rigidly adhered to, accurate inventories can be taken easily. A clerk skilled in the use of a slide rule can perform the calculations very quickly. This subject, however, is one requiring careful consideration. Often, if the system is properly devised, much detail work can be avoided without impairing the accuracy of the counter checks.

Records and Reports.—We now have a mass of data from which can be compiled a large number of most interesting reports. Only one part of this important subject can be touched upon in this article. Many others, however, such as auditors, purchasing agent, inspection, stock, cost, etc., tell valuable stories. All reports should be made by a

* The Engineering Magazine, August, 1902.

Work Ending	Output		No. Employees	Time		Pay Roll					Average Rate Earnings		Cost Operation	Supplementary Machine Rate	% Jobs Reaching Standard Time	Increases Decreases	
	Machines	Points		Total	Over-time	Total	Labor (Direct)	Piece Work	Day Work	% Piece Work To Total	Piece Work	Day Work	Per Point of Output			Where ?	Why ?

DEPARTMENTAL EFFICIENCY REPORT. DEPARTMENT NAME IS ENTERED AT THE HEAD.

special department or by one person. In the case of a small concern, the cost clerk should attend to this. All data necessary for reports or records of any character should be sent to this cost clerk. In addition to the data already mentioned, he should receive reports from which to compile the general factory and commercial charges, reports showing all expenses of running each department, number of employees, output, etc. As many reports are comparative, and the question of output usually enters into these, a better basis than mere "number of machines produced" is often necessary. Often the "cost of output" is a better basis. The term "point" may be used to represent any fixed value, as $25.00. All values of output can be reduced to "points," and the results made to serve a number of purposes.

Departmental Efficiency Reports.—This cut represents a departmental report devised and used by me. A report along similar lines will generally serve as a good basis for judging of the working efficiency of a department. The result of any period should be compared with some other corresponding period that can be considered a fair basis for comparison. Results of one month may be compared with either the results of the corresponding month of the preceding year or the average monthly results of the entire preceding year, or an average monthly result of corresponding seasons of business. Such comparisons will give a clear idea of whether or not a department is improving its work-

Week Ending	No. Employees	Output			Hours Worked		Pay Roll						Costs						Increases Decreases	
Year		Type	No. of Machines	Points	Total	Overtime	Total	Labor (Direct)	Piece Work	Day Work	% Piece Work To Total	% Jobs Standard Rate	Material	Assembling	Machining	General Charges	Total	Where ?	Why ?
1902																				
1901																				
1902																				
1901																				
1902																				
1901																				
Totals 1902																				
Total 1901																				

FACTORY OUTPUT AND EFFICIENCY REPORT.

ing condition. Especial attention should be directed to the piece-work and day-work records. It is almost invariably the case that the percentage of day work will increase as work grows slack, unless the departments are very closely systematized and supervised. The reasons for and results of such increases are apparent.

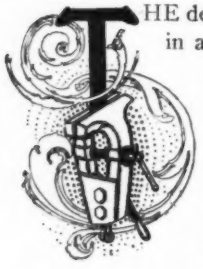
Consultations and Meetings with Heads of Departments.—All heads of departments should be consulted concerning their departmental records, reasons required for any deteriorations, and commendation bestowed for improvements. Large frames containing ten or more swinging blackboards upon which such forms are painted can be used with very good results. The records for each department are filled in with chalk, and all reports are considered in an open meeting of foremen and assistants. Such a method of procedure soon brings results. A foreman with a poor departmental record may feel that he has good reasons for a poor showing, but the fact that this showing will appear before his associates will augment, to an astonishing degree, his desire and efforts to improve it.

Factory Output and Cost Report.—This report will give a general idea of factory efficiency. The separation of costs as shown makes it possible to locate any increase or decrease immediately. Any factory manager will be richly repaid by such a series of reports.

THE RELATION OF THE DRAUGHTSMAN TO THE WORKSHOP.

By W. H. Booth.

One of the points of international difference in engineering practice most interesting to a trained observer is that of the position and treatment of the draughtsman. To a German engineer visiting America, for example, the difference in attitude of superior to subordinate—of chief to draughtsman—is so great as to be startling, and Mr. Lüders, writing in this Magazine in September and November, 1901, found in this one matter a very large factor in American engineering success. Mr. Booth's paper following, therefore, deals from the British viewpoint with a question of very great practical importance.—THE EDITORS.



HE determination of the draughtsman's proper functions in an effective shop organisation is a matter of considerable importance, and round it in its many phases much discussion, plaintive, acrimonious, and controversial, has arisen. To begin with, the very term is vague; for the name of engineer, which includes it, includes also, in British parlance, a vast concourse of men, ranging from the designer of a Forth Bridge or of a steam engine producing a horse-power hour for 11 pounds of steam, to the manufacturer of iron bedsteads or the driver of any type of engine.

The position of a draughtsman is by no means always a pleasant one. His duty in many cases consists very largely in adapting existing drawings to fresh purposes, effecting minor changes, and generally doing much routine work that possesses a minimum of engineering and scientific interest. He comes very little into contact with the outside world, and the utmost recognition he obtains from his immediate superior is contained in the words "my draughtsman," which are used when his work, perhaps, comes under the notice of some customer in the course of an explanation of what is being done. It is often said that he gets all the blame when things go wrong and secures none of the credit for what scores a magnificent success. There is much truth in this view, and it is doubtful whether the occupation will ever become popular unless remodelled on new lines. On the other hand, there are large numbers of men engaged in drawing who have very little preparation for the work. No youth ought to go into the

drawing office as a sequel to having learned to draw neatly at a technical school, for example. He should go first into the shops, where he will see drawings of a practical kind, learn what dimensions are necessary on a drawing, appreciate the value of an incorrect drawing correctly figured, and in fine, learn when a drawing is not a drawing and when it is.

The chief draughtsman of a certain colonial railroad known to me once insisted that the draughtsmen under his charge, who were frequently called upon to make sketches in the running shed, should actually make these sketches to scale, and he insisted they should figure these sketches with a particular pattern of figure, fractions being shown thus, ¼", with great regularity of style, and he insisted on the correction of a full-size drawing of part of a Bissel truck because a part which was correctly dimensioned to 24 inches actually scaled 1/64 inch from truth.

Many good men who would be welcomed in the drawing office today have been barred out in past years, because they could not draw nicely. The art of drawing nicely is not of particular value today in an engineer's office. It is not always the neatest writers who spell best and clear writing may but serve to show up more clearly bad spelling. A large proportion of the work of a drawing office is mere routine copying and "fudging in"—work of a kind that can soon be acquired by men who are mechanics rather than engineers in mind. The engineering is done by the chief draughtsman, and the others leave the drawing office after they have had a sufficient experience, or continue more or less as drudges. But there is and always has been a certain leaven amongst the draughtsmen to whom the engineering world is indebted for nine-tenths of its advance in engineering—men who understand principles—engineers, in fact, of all round ability, who are really the apostolic successors of the old millwrights of the stamp of the Rennies or Fairbairn. Every establishment may be said to possess the sort of draughtsman it deserves. There are many, too many, where he is expected to lie prone upon his board all day. He must never leave the office; the shops are barred to him; he is officially altogether in the dark as to the prices of the raw materials which he may select for constructing the work he designs; he may spend weary hours on a design to have it contemptuously blue-pencilled by his superior in position, who, as one might expect in such a place, is often far from his equal in ability.

A word here on the prone position. This is simply ridiculous. It wastes room, it injures the man physically, and it is quite needless.

With little practice any draughtsman can acquire facility in working on a vertical board. His T-square is balanced and carries a small ledge to stiffen it and to hold pencils and small tools. Another ledge at the bottom of the board carries all other tools. The board is adjustably balanced at any height, so that drawing is done at the level of greatest convenience. The operator stands upright, or uses a stool, and suffers less in eyes and nothing in chest. There is no excuse for the flat board. Artists have long used the vertical board and easel.

Conventionalism held the draughtsmen for long. A mechanical drawing had to be made on certain lines and rules, and it was copied by tracing. The sun print has done much to abolish the old system, but before this some men had broken loose from tradition and made their drawings with all black thick lines and put in dimension lines by hand, *i. e.*, without a ruler, and they abandoned all printing and wrote everything on the drawing; such drawings were even made on linen-backed paper and sent into the shops on their own drawing boards on which they were nailed with little copper tacks.

In the old days there was constant rivalry, or rather ill feeling, between the drawing office and the pattern shop and machine shop. Pieces would be drawn involving needless expense in patterns, and these needless expenses extended even to the foundry, while often heavy pieces had to be hand-fitted because they were too large to be done on the big planer. Such conditions were due to sheer ignorance on the part of the draughtsman as to what the limits of the machine were, or to indifference resulting from his acting up to the official ordering of his status—that he had no business with the shops. When the drawings went into the shop the draughtsman had done with them. To get out the work was the duty of the foremen, and the bolts to put the work together were obtained hap-hazard in many places.

There were scores of parallel practices, although perhaps no one place possessed them all and the smaller places possessed the fewest, and were really run on sounder lines than the larger works. In a small business the draughtsman is usually the engineer. He gets out all the plans, sees to construction in the shops, supervises erection outside, orders every scrap of material, and gets out estimates for new work. He carries the whole establishment on his shoulders. In his case drawing is reduced to its smallest proportions, and most details are perhaps mere hand sketches done in copying ink and copied onto buff sheets. There is no time for elaboration. The man has too much to do. When he disappears he has no competent successor. Now if this man and his methods be taken as a starting point for the

organisation of a large shop, the engineering department—a wider and better term than "drawing office"—might be placed on a sound footing. It ought to be the centre whence all emanates. In the first place, there should be lists of all machine tools, with the minimum capacity they can machine in length, breadth, and height and the maximum they should usually be expected to do. Detail drawings might even be numbered with the machine on which the draughtsman had designed they should be machined—not necessarily to be obligatory on the shop foreman, but as a guide for his use. No unusual work ought to be undertaken except in consultation with the pattern shop and foundry or forge. An example will serve to illustrate the importance of knowledge of all the particulars of a job. A cylinder or other drawing goes into the shop. The patterns for this may be substantial and expensive, or they may be cheap and consist largely of mere strickle boards. The expensive pattern costs say £10 and it costs 5 shillings in labour to mould it. The cheap patterns cost £3, but cost 10 shillings in labour to mould from them. They have therefore economised £6 15 shillings on a single casting. But if one hundred castings are wanted the pattern and labour cost of the expensive pattern will be £35 and of the cheap pattern will be £53. Thus the more expensive pattern is fully justified if a large number of castings are wanted, and if such matters are not worth communicating to all concerned then it is time to engage new foremen or a new manager.

When an order is to be executed, it should be put into the hands of the drawing office to decide on the method and materials of construction. The general scheme having been prepared, it is then to be decided what existing drawings can be utilised and patterns can be used from store, and what should be made new, and the extent of such patterns must be decided in accordance with the extent of their immediate and probable future use, as above suggested. A selection must be made of the materials to be employed, and here again many factors may enter into the estimate. Ease of manufacture may justify a greater expenditure on material. The possession of a heavy stock of a certain article may justify its use where a cheaper article would have been amply good enough if new material had been purchased. Thus one should not purchase new 3/4-inch bolts where a stock of 7/8-inch bolts of correct length is unlikely to find future employment. A stock of 1/2-inch plate might on occasion be drawn on where 7/16-inch was sufficiently strong. These are all points that should be within the knowledge of the office to utilise and within their power to decide. For this purpose, therefore, the schedule of stores ought to be kept up

to date and a copy kept in the office. This brings up the question of stores and the relation of the stores department to the other departments of the works. General stores of the soap and paint variety may be kept up by the head of the stores department, but the store of steel, bolts, plates, and in fact all constructional material, should never be ordered except in agreement with the drawing office, who should know the probabilities of the future and their own intention as to changing their practice in respect of any particular detail.

The design of large pieces has already been referred to as dependent upon the power and capacity of the machines upon which they are to be made. It might happen that a certain machine would be employed on other important work at the time that pieces were coming forward for a different contract. Some amount of foresight is required for such cases, and it might be wise to alter a design in order to avoid such a contingency, or to take the opportunity of purchasing a new machine, the cost of which would be offset by the economy to be secured on this particular order. It is only by attention to points like this that the works can avoid overloading certain machines with work while other machines stand idle.

The present very usual system of getting out estimates for new work in an estimating department quite distinct from the engineering department is wrong. The estimating department ought to be a part of the engineering department, and generally the engineering department ought to be the intelligence department of the establishment to which all information should be sent and from which the orders should emanate in respect of the use and purchase of materials and the general methods of constructing. The department would not interfere with the duties of the shop foremen, on whom of course must always rest the responsibility of getting out work. But before this duty comes to them they should be consulted by the draughtsmen on any more than ordinary operations, and the shop foreman, if worthy of his position, will be of the greatest value to the draughtsman, who will indeed very largely depend on his consultations with the foreman for keeping himself up to date in shop methods and in data relating to the time required on various operations. The time cost of an operation cannot be too exactly known. A thorough knowledge of time would enable piece work to be correctly priced out, and would prevent those errors which now cause so much trouble when rates are cut to correct them. Piece-work prices, in fact, very properly fall under the engineering department. A mere clerical department cannot properly take hold of this class of work—can-

not, in fact, take hold of it at all without help. A prime-cost department and piece-price department ought not to be clerical departments assisted by engineers, but ought to be an integral part of the engineering department, with such clerical assistance as may be required. The relegation of the drawing office to a subordinate position is sure evidence of the inability of the management in engineering questions.

For an engineer student some shop training is necessary to familiarise him with practical work, but by far the larger portion of his time ought to be spent in the engineering department—or, to use the commoner but less preferable term, the drawing office. In that department he would not merely learn to draw, but he would learn what weight to attach to the dimensions of a machine tool; he would become familiar with the lengths, sizes, and weights of materials of construction; he would be made acquainted with the sources whence such materials could be obtained, and would discover to what extent prices fluctuated; and he would acquire a sense of proportion as to the influence of prices and of wages upon construction. Mere drawing of a plan is not, or should not be, the end and aim of the drawing office. An engineer who knows what he wants can always make a drawing fit—perhaps not an old-time, fine-lined, shaded and artistic production, but one that another engineer will understand. The drawing office as it should be is the place above all others in which an engineer could be trained to a knowledge of his business in all its aspects, and if it were such a place, its value to the works of which it forms the brain would be very great.

At most places the work of the engineering department is done more or less badly because it is split up among other departments—estimating, stores, testing, manager, chief draughtsman, and shop foremen. It ought to be organised into one department under one head who will subdivide the duties among the staff, and in this way there will be harmony between the various operations of the works and an efficiency and economy at present rarely to be found. The constant intercourse between office and workshop will contribute greatly to the avoidance of red tape on the one hand and of careless work on the other hand. Incidentally it may be pointed out that all manner of operations that belong properly to the office are now done by shop foremen, who in place of looking after work become little better than junior draughtsmen. For example, it is no proper work for a foreman to hunt over a drawing in order to make out a list of bolts for the forge or stores. A sheet of bolts is as properly a "drawing" as is the drawing of a crankshaft, and should form part of the portfolio of

drawings for each job. There should be a separate sheet for bolts to be drawn from stock and bolts to be forged in the smithy. Bolts are named as an illustration merely as of almost universal employment, but the same arguments will apply in other directions.

The familiar saying that there are no old draughtsmen, is very true. The position is not what the intelligence and training of its best members entitle it to be, and if men are not killed off by the prone position they leave the drawing board for other work. Better management would place such other position very often within the radius of the engineering department.

Much of the recent discussion on the position of draughtsmen has taken place from the individualistic view of the correspondents themselves. They have recognised that there is something wrong with their condition, but have not realised that it is the system which is at fault and that the great body of draughtsmen can never be satisfactorily employed until their field of duty is widened. Making drawings without constant access to the shops is bad all round—it involves harder work and cannot pay the employer. Nor under ordinary conditions can a draughtsman properly fill up his day on close drawing. He ought to be an engineer, and being one should be expected to have an engineer's knowledge.

With a wider field of operation, there would appear no doubt a wider gap between the different classes of men now classed generally as draughtsmen. Many who now pass for draughtsmen would be graded as tracers, or return to the shops. This opens a new field of discussion beyond the scope and space of this article. Suffice it to say that engineering employers have willfully maintained their workshops in a dirty condition, and may thus fairly be charged with having invited a dirty class of workers and with having set themselves against the tidy superior man. Men of the stamp who tend to the workshop in America are driven out of old-style British shops by dirt, and until there are a fair number of new-style shops the number of superior workmen will not much increase. The lower grade of draughtsmen would make good shop workers in cleanly surroundings. It is all the fault of employers, not that their workmen act so blindly in obedience to ill-informed leaders, but that there is not an entirely different class of men to deal with—men who have education enough to repudiate false teachings. Employers have invited their workmen to be dirty and have got what they invited. The reorganisation of the drawing office is but a part of the whole necessary scheme of shop regeneration. tion.

EDITORIAL COMMENT

MR. ARCHER BROWN, in his strong, temperate, and conservative review of the iron-trade outlook which begins this number, touches upon one or two questions so actively disputed that his sense of fairness leads him to give the opposing arguments, rather than to attempt to state any final verdict. He says, very truly, that so long as the present remarkably good times continue in the United States, none of these political or economic problems are likely to be taken up for final settlement. But when the time comes when the United States must deal again with the trade of the world—and "it will come," Mr. Brown says—some of these determinations will be no longer delayed, notably the tariff question. It is certain that a very strong undercurrent is setting toward tariff revision, and will come to the surface as soon as the flood tide of prosperity is checked. Now, everyone is too busy or too indifferent to question closely the protectionist propaganda. Meantime the high-tariff worshipper bows himself in the house of his gods. "A defender of the protection system has only to point to the unexampled activity of the United States, while her great trade rival is languishing in business depression," to give his answer. So says Mr. Brown, assuming for the moment that point of view. It is precisely the style of answer the protectionist would and does give, and it would satisfy for a moment no one but the protectionist himself, nor him very long after a well-informed free-trade cross-examiner had had him in hand.

Suppose the protectionists' interlocutor, straying from the narrow track of vision measured out for him, should chance to turn his eyes on protectionist Germany, stricken with an industrial stagnation beside which the "languishment" of England is the very hum of busy activity. How would *that* comparison affect the sufficiency of the protectionist "answer"? Or suppose he should chance to turn back a paragraph or two in his industrial history, and look at the situation four or five years ago, when free-trade England was teeming with business and protectionist America was "languishing"—languishing so pitifully, indeed, that in very despair she sought those foreign markets which, Mr. Brown says, realize for manufacturers "the best prices, in times of depression at home"—those markets which England always enjoys.

Suppose, indeed, this unconvinced free-trader should examine closely into conditions in languishing England, and find that her "business depression" (already, by the way, rapidly rising again to normal) was after all only a somewhat relaxed business activity; that, instead of the dire results experienced in America in 1897-8, and in Germany in 1900-1—panics, failures, collapses of inflated ventures, shrinkages of overblown combinations, ruin of investors and painful reorganisation of survivors—instead of this, British "business depression" was displayed only by a smaller surplus of orders, a somewhat decreased pressure of work, a decrease of the rate of increase, rather than any decrease of trade itself. Suppose he should see not only these

facts, but incidentally that the broad foundations of Britain's free trade with all the world spread so far and were laid so deep that no national depression could seriously menace or weaken the great structure—that her valleys of depression were small and shallow, while those of protectionist America and Germany were abysmal.

What would be left of the force of the protectionist's "answer"?

* * *

It has often been said of late that the age of trade has superseded the age of conquest. Industry, not war, seeks and demands new and ever-widening worlds. Napoleon's spell lies not alone in what he did, but in the knowledge that such things are no longer doable, or even thinkable. He is the last of the military conquerors, and the world, though still half-fascinated, breathes freely in the feeling that the race is extinct.

But it is not so generally believed that the change is in manifestation only. The type persists; the sphere alone is changed. The flippant term "Napoleon of Finance" embodies a fundamental truth. The same restlessness of conscious power, the same hungering for empire, the same craving for the intoxication of victory, now find in the field of industry the outlet that once was to be found only in the field of battle. And the same glamor of immediate success dazzles the people and throngs them about the victor, delirious in the glory of the present, careless of the stability of the future. But the same law underlies all nature, and will not be denied. The overblown bubble will burst—the overstretched fabric will break—the unstable structure will fall. The retreat from Moscow, Leipzig, Waterloo, were only incidents of an inevitable result—not prime causes of Napoleon's ruin. Contempt of economic and political conditions, contempt of men and the natural rights of mankind, extension of the State beyond the powers of statesmanship to manage, reliance on military prowess as the supreme force—these brought the whole vast Empire to a pass where military skill was utterly overwhelmed by the reassertion of natural forces.

The analogy is plain. The American leaders of finance, beginning with undertakings which had economic justification, but since drunken with success, have expanded their campaign to the limits of dreamland. Not content even with control of one industrial kingdom, they would gather them all into one empire. To the conquered world of manufacture they would add the conquered world of transportation. Making, selling, distributing—all are to be ruled by the one head. Individual initiative, emulation, competition, are to be set aside. "Community of interest" is to be the economic motive of the future. And by that policy the Napoleons of Finance, gathered in their little council, propose to direct the world.

* * *

So far, as with Napoleon's first armies, the madness of battle and the thirst for spoils have held together their followers; the paralysis of fear has held back their opponents. But because, and to the extent that, they have rejected the wisdom of the founders of the states they are undertaking to combine into a towering empire, they are rushing toward wreck. When the "financier" leaves the engineer and the industrial manager out of his counsels, the end of his triumphant progress is in sight. When success in floating securities is put above success in mechanical invention, in works organization, in labor handling, and in cost reduction, the defeat of the "American invasion" is close at hand.

For some irreverent watchers find another sort of *rationale* closely inter-

woven with the desire of conquest, and that is the desire of "unloading." "It is all very well," says the N. Y. *Evening Post*, "for corporations and banks to pass on the inflated securities from one to the other, but all is in unstable equilibrium unless a final resting-place can be found in the small purchaser, who cannot, in turn, unload. 'Oh, that I knew where I might find him!' is the sigh of the would-be unloader, longing for the small buyer, in great numbers, but not of too great perspicacity. Of what avail is it to have heaps upon heaps of common stock, which you have got as a bonus, unless you can unload?" "The only people who have reason to fear Trusts," said Andrew Carnegie, "are those who trust them." But of these there are yet many—"the widow with small savings; the clergyman with a tidy sum laid up for a rainy day; the executor with trust funds to place where they will yield a secure return for the orphans under his charge." These throng the recruiting stations of the Napoleons of Finance, who gather in their millions and prepare conscription (pardon! *sub*-scription) lists for their hundreds of millions. A like recklessness led to Napoleon's winter campaign in Russia. What will be the suffering, and what the proportion of loss, in the impending retreat of the American Napoleons of Finance?

* * *

It has been pointed out that one of the immediate consequences of the strike in the anthracite coal regions will doubtless be the more general introduction of machinery for all operations possible, and there is no doubt that numerous advantages would result from this course. Apart from the effect which this may have upon the labor situation, it is to be encouraged, as should be every change which removes from the shoulders of human beings laborious and difficult work which can be performed by machinery.

There is another engineering problem, however, which the scarcity of anthracite coal should bring into prominence, one which is at least partially solved, and which is capable of complete solution if it but receives the commercial attention which its importance demands. The only objection to the general use of bituminous coal for all purposes is the production of smoke which generally accompanies its combustion. No one objects to soft coal in itself, but every one is opposed to the production of the smoke, soot, and cinders, fouling the atmosphere and rendering personal cleanliness difficult, if not impossible, in large cities.

The question therefore resolves itself into the rigid enforcement of ordinances against the production of smoke within city limits, regardless of the nature of the fuel employed. A large portion of the smoke produced by the use of bituminous coal results from attempts to burn it in furnaces originally designed for anthracite. In such cases the production of smoke is inevitable, since the relation of the grate to the boiler surface, or other point of application, is incorrect, the air supply is lacking in amount and location, and the general conditions for complete combustion are altogether absent.

When it is understood, however, that the supply of anthracite coal is distinctly limited, even when no labor troubles exist, it is evident that no time should be lost in equipping the furnaces in large cities with proper appliances for burning soft coal without the production of smoke. That this can be done is not denied, but that it would cost some money to make the change must be admitted. At the same time it is a question if the expense which has already been incurred in the purchase of anthracite coal at abnormally high prices would not have sufficed to have equipped all the fur-

naces in which that coal has been burned so that they might hereafter use bituminous coal without incurring any unfavorable comment by reason of violation of smoke-prevention ordinances. The resetting of steam boilers is by no means a simple task, but it need not be done immediately, the limited life of a boiler rendering its replacement inevitable within a few years in any case, when the change in furnace construction could be made at a nominal cost in most instances.

The present condition of affairs should lead steam users to consider very seriously the modification of their steam plant in such a manner as to render them altogether independent of the character of the fuel to be used, and thus take them out of the present dilemma of paying exorbitant prices for a special kind of fuel, or of violating ordinances which all must admit should be respected for the general good of the community.

* * *

LOOKING still farther ahead in connection with the generation and distribution of power in large cities, it is evident that the time must come when the generation of steam by the burning of solid fuel shall be abandoned within city limits. Apart from the extent to which the air is fouled by the discharges from furnace chimneys, the question of the inferior efficiency of many small furnaces as compared with large generating plants must be considered. When the greater additional economy of the internal-combustion engine is considered, it is evident that the true solution of the smoke-prevention problem lies in the substitution of the gas producer for the wasteful coal furnace, and the doubling of engine economy by the employment of the gas engine in place of the steam engine. The facility with which fuel gas may be distributed renders it possible to have the gas producers situated without city limits, while the construction of large gas engines is now so well assured a fact that no limitations need be placed upon the size of the local power plants. In many instances the power may be generated altogether without the city, and distributed electrically, thus doing away altogether with the installation of prime movers in the city. That such a plan will become the ultimate solution of the smoke problem can hardly be doubted, and while it may not be realized immediately, there is no one thing which can help more to bring it about than the utter disregard which has been shown of the rights of the user of fuel by both parties in the present labor dispute in the anthracite coal regions.

* * *

THE commercial importance of Canada to the United States has been recognized by THE ENGINEERING MAGAZINE for some time, as witness the succession of articles we have published during recent years dealing with engineering and mining development in the Dominion. From Nova Scotia to British Columbia are to be found some most significant undertakings—significant especially in a wide view of the tendencies of industry and trade. And not only at home, but as far as the West Indies on the Atlantic side, and as far as the Orient on the Pacific side, Canadian capital and energy is extending its sphere. It cannot be said that the trade relations of the United States with this nearest and most promising neighbor are anything like satisfactory, although the opportunities for mutual advantage in Canada's rapid advance are many and great. The movement for tariff revision, which is gaining irresistible headway in the States, might well be directed early to improving our relations with the Dominion across the northern boundary.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

ENGINEERING CONSIDERED AS APPLIED SCIENCE.

THE COMMERCIAL VALUE OF THE THEORETICAL MAN—SCIENTIFIC METHODS AS AN AID TO MANUFACTURE AND COMMERCE.

An Editorial Discussion in "Engineering."

IT has long been the custom in most civilized countries to differentiate clearly between the theoretical and the practical man, and very often the latter has felt it incumbent upon himself to disclaim a knowledge of the theoretical side of his subject in order to emphasize his supposed practical ability. This curious separation of two elements which naturally appear to be most necessary to each other, is now, however, becoming less frequent than formerly, and observant men are perceiving that in those countries and those establishments in which theory and practice are most closely united the greatest commercial success is being attained.

While it is not always safe to assume that events which appear in a certain sequence bear the relation of cause and effect, or even that they are all effects of some preceding cause, yet when such relations are observed again and again, the matter is at least worthy of investigation.

In a recent editorial discussion upon the subject of Science and Practice, *Engineering* compares the practical adaptation of scientific methods in England with those in other countries, and shows that in every instance in which the combination has been thoroughly effected the control of the industry under consideration has been secured.

Thus, in Great Britain, mechanical engineering has been made the subject of exhaustive theoretical and scientific study, and the results of these studies have been promptly and effectively appropriated by the builders of tools and machinery, so that in these lines Britain is second to no other nation. In the chemical trades, however, the situation is altogether different. Thus up to the year 1872, Great Britain held a commanding position in this department of industry. Since then, however, the energy with which the latest scientific work has been applied to practice in Germany has resulted in a greatly changed condition of affairs. That this change is due to the proper application of scientific research is most evident. Thus in the aniline color industry, in which Great Britain has undoubtedly neglected the scientific side of the work, not 5 per cent. of the dyes used are of domestic origin, the balance being mainly imported from Germany. In contrast to this we see the commanding position held by the British representatives of the Solvay ammonia soda process, an industry in which the scientific and technical side has been maintained well in advance of the Continental establishments. Another example of the manner in which the application of scientific research has resulted in the loss of position to England is seen in the matter of optical glass, an industry in which Britain at one time held the lead. Here the firm of Zeiss & Co., of Jena, and its associates, by sheer dint of painstaking research and investigation, assisted by Government liberality, grasped a line of manufacture entirely in other hands, and to-day holds a supremacy which England might well have maintained had her manufacturers seen fit to give proper attention to scientific methods and resources.

A notable instance of the enormous commercial advantage resulting from the application of science to industry is seen in the metallurgy of iron and steel. In the course of a recent address at the Stevens Institute, Mr. Andrew Carnegie affirmed that the great advance of his firm in the manufacture of iron and steel lay in their early employment of a competent chemist, a spectacled German, by the way. By a proper analysis of ores it was found that suitable material, for which a high price had formerly been paid, could be obtained at a much lower figure, the cheaper ore not having been thought worth using by the "practical" men who had previously made the selection. By the most rigid practical use of the latest scientific methods of investigation, the great aggregation of works now controlling the steel trade of the United States has been built up, according to the authoritative statement of Mr. Carnegie himself.

The same is true on the Continent. Both in Germany and in France the chemical laboratory and the testing bureau form most important elements in the success of such works as Krupp's or Creusot. The result we see in the advance which Krupp has made in the construction of armor plate, and in modern artillery by Canet at Creusot. Alike in England, Germany, France, the United States, we see the industries which have availed themselves of the work of the scientist, pushing to the front and controlling the department of work to which they are devoted. Results such as these are not to be explained away, they need no explaining away. Instead of endeavoring to show that the success may be due to some other cause, or of arguing or discussing the subject at all, all energy should be devoted to a determined effort to unite science with practice in every conceivable line of work. Empirical methods must be used when rational ones cannot be found, but the search for the rational method should never be relaxed, for we may rest assured that the man with the rational scientific command of his work must surely overtake the man of empirical routine.

THE COMMERCIAL PRODUCTION OF OXYGEN.

A PRACTICAL APPLICATION OF LIQUID AIR—FRACTIONAL DISTILLATION DIRECTED TO THE SEPARATION OF NITROGEN FROM OXYGEN.

Prof. Von Linde, in the Zeitschrift des Vereines Deutscher Ingenieure.

AMONG the important papers presented at the recent meeting of the Verein deutscher Ingenieure at Düsseldorf may be noted that by Professor von Linde, upon the commercial production of oxygen by the fractional distillation of liquid air. It is to Professor Linde that we owe the original development of the cumulative process of refrigeration, by means of which it has been found possible to reach the critical temperature of air, and thus liquefy it by compression, and his paper upon the practicability of thus making a useful application of the discovery is a matter of present interest. The paper is given in full in the *Zeitschrift des Vereines deutscher Ingenieure.*

The critical temperature of air at the pressure of the atmosphere is about—191 degrees centigrade, and until this temperature is attained the air cannot be liquefied by compression. The principal constituents, the oxygen and the nitrogen, however, have different boiling points, the nitrogen evaporating at —195.5 degrees, while the oxygen does not assume the gaseous state until the temperature has risen to —182.5 degrees. It is this difference of 13 degrees between the two boiling points which renders it possible to separate the oxygen from the nitrogen. As a matter of fact the evaporation reduces the total quantity of liquid to a readily calculable extent. Since there are four cubic metres of nitrogen to one of oxygen about 60 per cent. of the liquid will be evaporated when the remaining liquid consists of equal parts of oxygen and nitrogen, and if pure oxygen is required, the evaporation may be carried to any further extent desired.

It is manifestly impossible, however, to produce oxygen by this process on a commercial scale if the supply of liquid air is to be maintained by the usual process of cumulative cooling and compression. To liquefy a cubic metre of air requires the

expenditure of 2 horse power, and of this cubic metre but one-fifth is oxygen. It is therefore necessary to devise some less expensive method of obtaining a continuous supply of liquid air.

Since the greater part of the energy expended in producing liquid air is required for lowering the temperature, it is evident that this can be saved by a judicious use of the cold produced by the evaporating nitrogen. Since the oxygen is also most useful in the gaseous state, the cold produced by the entire evaporation of a given quantity of liquid air may be used for cooling an equivalent quantity of fresh air drawn from the atmosphere, and the only expenditure of power required is the small amount necessary to liquefy it after the critical temperature has been reached.

In this respect the method of Linde is identical with that already described by Pictet in a paper presented before the Société des Ingenieurs Civils de France and reviewed in these columns. The principal difference between the two systems lies in the detailed construction of the apparatus, Professor Linde employing a "counter-current" cooling device practically identical with that used by him in his original apparatus for liquefying air. In his present paper he gives details of a larger arrangement adapted for the evaporation and liquefaction of air on a commercial scale.

It will be seen that the whole operation is a very simple one, both in theory and practice. A given quantity of air requires that a large quantity of heat shall be abstracted from it. When this same quantity of liquid air is permitted, by evaporation, to return to the gaseous state, it abstracts from surrounding bodies, the same quantity of heat. This abstraction of heat is effected just as well if the constituent oxygen and nitrogen are permitted to evaporate successively as if they evaporated together. The apparatus need only be so arranged that the evaporating nitrogen and oxygen are brought into close proximity to the incoming air which is to be liquefied, and these details may readily be arranged in more than one manner.

Naturally the principal question connected with the whole subject is that of the cost. The practical uses of pure oxygen, or even of a rich mixture of oxygen and nitrogen, in the arts are numerous and unquestioned, if only the price can be brought within commercial limitations. Professor Linde gives some data which may serve to indicate the possible cost of making oxygen by the fractional distillation of liquid, and the use of the cold thus produced to yield a fresh supply of liquid air for the continuation of the process. At the works of the Linde Ice Machine Company, at Munich, an experimental plant of 150 horse power has been erected, and this has been in operation for several months. It has been found that, by the expenditure of 100 horse power there can be produced 100 cubic metres per hour, of a mixture consisting of equal parts of oxygen and nitrogen. For many purposes this rich mixture is ample, and in metallurgical operations and the like it may find extensive uses. The production of pure oxygen is naturally more expensive, but as the result of his experiments Professor Linde states that it can be produced at the rate of half a cubic metre per hour per horse power. If therefore the cost of power in any locality be given, the cost of oxygen can be readily determined.

MODERN BASE-LINE MEASUREMENTS.

THE RAPID AND ACCURATE WORK OF THE UNITED STATES COAST AND GEODETIC SURVEY ON THE 98TH MERIDIAN.

John Hayford, in Engineering News.

IN making a geodetic survey the accurate measurement of the base line upon which the system of triangulation is developed has always been considered the most important feature of the work. Various systems have been devised for enabling the engineer to measure bases of several miles in length with a very high degree of precision, some of these methods being so elaborate as to require an equipment resembling an astronomical observatory with the services of a staff of experts.

In striking contrast to the excessive elaboration of some of the systems which have

been developed, is the business-like plan adopted by the United States Geodetic Survey in connection with the triangulation along the 98th meridian. This work, which was conducted under the direction of Mr. A. L. Baldwin, is described in a very interesting paper by Mr. John J. Hayford, in a recent issue of *Engineering News*.

The Geodetic Survey of the United States has had in hand the completion of two most important systems of triangulation; one extending across the continent along the line of the 39th parallel, and the other running along the 98th meridian from Canada to Mexico. These two systems bisect the country both north and south and east and west, and when completed will form the main framework or control for all surveys in the United States.

The plans for the triangulation of the 98th meridian provided for the measurement of nine bases at various points from Nebraska to Texas, and it is of the practical methods used in this work that Mr. Hayford writes.

The methods employed were unique. Instead of measuring one base and then conducting the triangulation to the location of the next base and measuring the latter, and so on, it was decided to measure all nine of the bases before any of the triangulation work was done. This enabled the entire work of base measuring to be done by one party, with one set of apparatus in a single season, thus eliminating many causes of discrepancy, besides reducing the cost.

So far as accuracy is concerned, the influence of a certain degree of error in the base upon the accuracy of the entire survey is discussed in an interesting manner. As a matter of fact there is a practical working limit of error beyond which any higher degree of precision is of minor importance. The errors due to the angle measurements are always much larger than the errors of the base measurement. It can be shown that very little increase in the average accuracy of the triangulation would result from increasing the accuracy of the base measurement beyond that represented by a probable error of one part in 500,000, even were the base measurement made absolutely perfect. It was therefore decided to keep within a probable error of one part in 500,000, and to devote the effort available beyond the requirements for that degree of precision to the economy of time and money. The result was the measurement of nine bases, ranging from 6,000 to 12,000 metres in length, situated in a stretch of country of more than 1,600 miles in length, the probable error of the nine bases being 1 part in 1,200,000. This work was done by a party of 10 persons in a period of six months, at a total cost of $11,075, this cost including field and office work, pay of all men, and transportation to and from Washington. The cost of the work was $160 per kilometre, or $260 per mile of base measured.

The method employed is described very fully by Mr. Hayford, while the detailed report of the work is included in the report of the Geodetic Survey. Five sets of apparatus of two different types were used, there being four steel tapes, and one bar apparatus. In addition to this there was employed the very accurate iced-bar apparatus designed by Professor Woodward, and used in the measurement of the Holton base in Indiana, this being used for standardizing the tapes and bar apparatus. The iced bar is 5 metres long, and being kept at a uniform temperature by contact with ice in a trough, the temperature error is entirely eliminated. This bar apparatus was used to establish two field comparators consisting essentially of stone monuments 100 metres apart. One of these comparators was at the Shelton base in Nebraska, and the other at the Seguin base in Texas, and by measuring these distances with the working apparatus at the commencement and the close of the work under similar conditions to those encountered in the regular base measurements, the accuracy of the work was kept within reasonable control.

For details of the work the reader must be referred to Mr. Hayford's paper, but it may be mentioned here that the work with the steel tapes was found to be fully within the prescribed limits of accuracy, while much more rapidly performed. The experience obtained in this work confirmed the general opinion of engineers that temperature errors are the most serious to be encountered in base measurement.

In this connection it is much to be regretted that the measurements did not include the use of one or more tapes made of the 36 per cent. nickel-steel alloy dis-

covered by M. Guillaume, of the International Bureau of Weights and Measures at Paris, and found to possess a co-efficient of expansion far lower than any other material known. It is altogether possible that tapes made of this nickel-steel alloy, when once standardized, may be used for base measurements without requiring any precautions to be taken with the respect to temperature errors, the variations due to the ordinary atmospheric range of temperature being practically inappreciable.

The valuable feature about the whole account of the measurement of these bases is the intensely practical manner in which the work was carried, while at the same time full regard for the scientific requirements of the task was maintained. It shows quite as high a degree of scientific refinement to perceive the lower limit of accuracy in such work as to approach the upper limit, and the man who insists upon a degree of precision in one portion of an undertaking out of all proportion to the possible attainment in other portions, is far from being a truly scientific engineer. If all government work was performed with such a just appreciation of the proper balance between accuracy, speed, and cost as has been exhibited in the measurement of these bases, there would be cause of great congratulation, and greater satisfaction.

INTENSIFIED METHODS IN BUILDING CONSTRUCTION.

HOW THE NEW BUILDINGS FOR THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY WERE RUSHED THROUGH.

The Story of One of the Participants.

ABOUT three years ago we referred in these columns to the plans which were then announced concerning the construction of the new works for the British Westinghouse Electrical and Manufacturing Company, at Trafford Park, near Manchester, and called attention to the fact that these works, when completed would be an exponent of American methods as applied under British conditions. Now we have, in a recent issue of the *Journal of the Western Society of Engineers* a most interesting paper by Mr. William G. Sloan, describing the manner in which American methods have been applied to push the completion of these works, regardless of British conventions and customs. Says Mr. Sloan:

"The plant was designed by Thos. Rodd of Pittsburgh, and the work of construction was intrusted to a Manchester architect, but under his supervision the work progressed so slowly that it was evident to those interested something must be done to hasten the work. It was generally conceded by English builders that it would take five years to erect the works contemplated, and now, when the proposed output of the plant was most in demand, a delay of a year or two years meant an almost inestimable loss. The question was, How can the plant be completed in the shortest possible time? The Americans interested in the business naturally looked to America for an answer to this question, and the contracting firm of James Stewart & Co. of St. Louis and Pittsburgh were asked to take hold of the work and push it through. This they agreed to do, saying they could complete the work in 15 months.

"Therefore a year ago last March, J. C. Stewart of the above firm, having gathered around him a party of six American engineers and foremen, of which party I was fortunate enough to be a member, sailed for England, and on arriving there took immediate charge of the work.

"It was evident at a glance that a complete reorganization was necessary, in the making of which we naturally met with considerable opposition, but Mr. Stewart was determined in his purpose to do the work, as far as possible, by American methods, and not many weeks passed before we had things running to our satisfaction. We found the work in charge, under an architect, of a clerk of works, who had a small office in one part of the grounds. This man had perhaps a dozen assistants, each having his little office in some part of the grounds, each seemingly as far as possible from the others. The first thing done was to build an office large enough to accommodate all the necessary force, so as to bring them under the immediate supervision and influence of the

American management. All these men had been in the habit of coming on the work at 9 o'clock in the morning and leaving about 5 in the afternoon; they were requested to be on hand when the work started and to remain until quitting time, and this request caused about half of them to seek employment elsewhere."

Following closely upon this reorganization of the office staff came the removal of slack methods among the men. First among these was the custom of stopping for a half-hour, in the best part of the morning, for tea, a custom unknown in America, though most universal in England. This was soon done away with almost altogether, and full time being made by all concerned, the output began to improve. One of the most important portions of the work was the bricklaying, and by securing the best men, and paying somewhat more than the union rate of wages, the number of brick laid per day was greatly increased. Shortly after the new administration took hold of the work the statement was made that the men at Trafford Park were laying more than 900 brick per man per day. This was received with incredulity elsewhere, the usual quantity being from 400 to 500 per day. Later on, as the organization became better, and the men became accustomed to American methods, this average of 900 brick per day was doubled on the same class of work. This caused so much comment that it was thought advisable to have the facts verified, and on the construction of the large brick stack the foremen made affidavits as to the number of brick laid per man per day. The average was more than 1,900 brick per man per day, the best day's work being 2,100 per man.

Mr. Sloan's comment upon the conditions which made such improvements possible are best given in his own words.

"That such a condition can exist is made possible by the fact that, considering the cost of material in England, the contracting prices of doing work generally are away above those of doing corresponding work in this country. To my mind this difference in cost represents what is lost by slack methods of handling work; not slack as far as quality of the work is concerned, but slack in every other way. It is something which only keen competition can overcome.

"England has been pre-eminent in so many lines of industry for such a long time that she has, as it were, been resting on her laurels, not realizing that in other parts of the world tremendous advances were being made along these same lines, and that other countries were assuming an importance in the industrial and commercial world which made England's position uncertain. Some progressive Englishmen realized this long ago, and some are just learning the lesson, but the great majority in their conservatism have it still to learn. Go into 99 out of 100 manufacturing establishments of any kind in England and examine the tools and appliances for doing work. You will probably find the same kind of machines used there to-day which were used and discarded in this country 25 years ago. So long as a machine does its work it is satisfactory; the Englishman has not yet come to the point where, by sitting down and carefully figuring out his cost account, he finds that it may be economy to discard a machine, even though it is doing good work, and replace it by one which will do that same work quicker and at less cost. It has been well said, the English manufacturer does not know the value of a scrap pile."

The most interesting feature in this whole matter appears to be the fact that not the slightest difficulty was experienced with the British workmen by the American contractors. We have been so much accustomed of late to hear all the blame for the present condition of British trade to be laid upon the workman and his methods, that it is most refreshing to see that the only apparent difficulty experienced by Mr. Stewart was with members of the staff and with customs and traditions. The former were readily replaced and the latter gradually overcome, while the workmen seems to have fallen into the new order of things with but small difficulty.

The real causes of the success of the work appears to have lain chiefly in the tireless energy of the contractors themselves, and in the fact that the sub-managers and assistants rendered most willing and efficient service. To this must be added the effect of keeping careful records of each day's work and the unsparing use of the most approved mechanical appliances wherever the work could thereby be facilitated.

SOME ELEMENTS OF STEAM ECONOMY.

THE MOOTED QUESTION OF THE INFLUENCE OF STEAM JACKETS AND REHEATERS IN MULTIPLE-EXPANSION ENGINES.

Experiments at the Durham College of Science.

AMONG the papers presented at the Newcastle meeting of the Institution of Mechanical Engineers, that by Professor Weighton, discussing some experiments on steam engine economy attracted attention, and elicited discussion. From the paper itself we make some abstracts, reviewing them in the light of experience elsewhere, and calling attention to some interesting comments which have been made upon it editorially by the *Engineer*, and by *Engineering News*.

Professor Weighton's investigations were made upon the small experimental engine in the laboratory of the Durham College of Science, Newcastle-upon-Tyne, one series being intended to determine the economical effect of reheating the steam passing through the receiver of a double-expansion or compound engine; the second series being to determine the influence of the degree of vacuum in the condenser of a triple expansion engine.

The data and results of the tests are given in detail in Professor Weighton's original paper, to which reference should be made. It is sufficient to state here the general results. A reheating coil was arranged in the receiver so that live steam could be admitted or withheld without changing any of the other conditions of operation. Trials were then made without steam in the reheater coils, followed immediately by similar experiments with live steam in the reheater.

The results of these two methods of operation are summed up in two groups; one, showing the favorable influence of the reheating and the other its losses. In the first category it appears that the reheating acts favorably in the following respects: It reduces the amount of condensation in the receiver, raises the receiver pressure, raises the mean pressure in the engine, increases the engine speed, and furnishes dryer steam to the low-pressure cylinder.

These advantages, however, are obtained at the expense of a reduced mechanical efficiency of the engine, and of an increased steam consumption per horse power developed. In other words, the consumption of steam in the reheater coils amounted to more than the saving in the cylinders. It is true the increase shown in steam consumption was very slight, while the decrease in mechanical efficiency is thought to be due to the greater dryness of the working steam, after reheating.

So far as the reheating itself is concerned, the results recall the interesting tests made ten or twelve years ago by Professor J. E. Denton upon the Pawtucket pumping engine, and the subsequent tests, also made by Professor Denton, upon a triple-expansion pumping engine used on pipe-line service. In both of these important trials, made upon a far larger scale than was possible with the small laboratory engine used by Professor Weighton, the results showed that little or no economy was attained by the use of live steam in jackets. Similar results were obtained in several tests by Mr. George H. Barrus, who, in his book recording his many engine tests, says that 2 per cent. is the most that can be expected for the saving due to jackets and reheaters. In regard to the actual influence of reheating upon the engine, Mr. Barrus arrived at the same results as Professor Weighton several years ago. Says he: "Whatever the actual economy due to jacketing or to reheating, or to both, which from the evidence of these tests appears to be rather small, there is no question but that the action of the jacket and the reheater produces a powerful influence on the steam in its passage through the cylinders. The effect upon the indicator diagrams is very marked. The use of these appliances makes the engine more powerful in view of the fact that it increases the work done by the low-pressure cylinder for a given amount performed by the high-pressure cylinder."

Professor Weighton's experiments upon the effect of a high vacuum upon economy, show results confirmatory of those known already in practice; namely, that there is no appreciable advantage in carrying a vacuum higher than 26 inches of mercury. It is

doubtless true that a higher vacuum will cause the engine to produce more power, but the gain will be at the expense of a greater volume of condensing water, and the increased burden overcomes the gain.

So far as steam economy is concerned there is no doubt that the point of attack is the reduction of cylinder condensation, but with modern engines at least it seems fairly well demonstrated that the use of live steam outside of the cylinder is not an economical way to prevent condensation within it. It does the work, to a certain extent, but it costs more than it saves. Far more promising are the results attained by superheating, not only because they can be made to prevent condensation more effectively, but also because they are attained by the utilization of heat which would otherwise be wasted, the heat of the discharge gases of the boiler. As for the influence of dry or superheated steam upon the mechanical efficiency of the engine, that is a matter for engine designers to look to proper provision for lubrication, avoidance of unequal strains from expansion, and a general provision for the changed nature of the working fluid can readily enable the engine to do its work all right. The main thing to be remembered is that the machine is a *steam* engine, and that water in any other than the gaseous state is absolutely out of place anywhere in the working cylinders. When this point is assured the economy of the steam in the engine will be obtained, and it remains only to see that the gain thus secured is not offset by the nature of the method adopted to prevent the presence or formation of water in the liquid state.

It may be noted in this connection that an economy of steam does not necessarily mean an economy of money and usually it is the latter feature in which mill owners and engine proprietors are most deeply interested. The engineer of to-day must be an economist in a broader sense than was formerly considered necessary. The cost of power includes many items, such as interest, depreciation, repairs, attendance, etc., and the economy of steam which results in the economy of money is that which in the course of its attainment does not increase unduly the other elements which unite with it to make up the total cost.

MODERN TRANSATLANTIC STEAMSHIPS.

THE DEVELOPMENT OF BRITISH AND GERMAN COMPETITION IN SHIPBUILDING AND MARINE SUPREMACY.

The Launch of the Next Record-Breaker.

IN providing for the great and increasing traffic across the north Atlantic there are several conditions which must be met, and these conditions have, in varying degree influenced the growth and modifications in steamship construction. Naturally the first nation in the field, if it may be so called, was Great Britain, and for many years the great British steamship lines controlled and commanded the traffic. At first the crossing of the Atlantic was considered a feat which, if effected in safety, and with some moderate degree of comfort, was considered to have been most successfully accomplished. To-day it is a trip which is made with small concern by thousands, the cities of Europe and America often being mentioned as forming portions of a journay without referring to the existence of 3,000 miles of ocean between them.

The first of the conditions above referred to as existing in the case of ocean traffic is that of safety. Formerly this was a matter which entered largely into the selection of line and steamer, but now it is fully understood that the modern methods of construction and operation are the property of all lines alike, and that there is little or no choice in this respect. Following close upon safety comes the question of speed, and for a time the possession of the record breaker was a valuable asset for a transatlantic line. Following close upon safety and speed comes comfort and luxury, and to-day the traveller is not content with being transported across the Atlantic with safety and a fair degree of speed, but demands such freedom from care and discomfort as is made possible everywhere else for those who are in a position to demand it.

It is in this latter requirement that we may look for the success of the continental

steamship lines, and especially for the great progress which has been made in the past few years by the great German lines.

These questions are brought into immediate consideration by the accounts which have appeared of the launch of the latest German liner, the Kaiser Wilhelm II, and the comparisons which this event has caused between the British and German lines in general.

For details of the latest and greatest of the German transatlantic steamships reference may be made to recent issues of the *Zeitschrift des Vereines deutscher Ingenieure* and to late numbers of *Engineering*, while in the editorial columns of the latter journal some interesting points in connection with the whole subject are brought out.

Naturally the latest developments in shipbuilding have been in the direction of greater size and higher powering, and in these respects Germany is maintaining the lead she set with the Kaiser Wilhelm der Grosse in 1897. The following table shows clearly the successive developments in the building of large steamships, and the preponderance apparent in the German vessels is most apparent.

Vessel.	Date.	Length.	Displacement.	Power.	Speed.
Kaiser Wilhelm II.....	1902	706 ft.	26,000 tons	40,000 hp.	24 knots
Kronprinz Wilhelm	1901	663 "	21,300 "	36,000 "	23.5 "
Deutschland	1900	684 "	23,620 "	36,000 "	23.5 "
Kaiser W. d Grosse.....	1898	648 "	20,880 "	30,000 "	23 "
Campania	1893	622 "	18,000 "	30,000 "	22 "
Oceanic	1899	704 "	28,000 "	27,000 "	20.7 "
Lorraine	1900	582 "	15,400 "	22,000 "	21.9 "

Thus it appears that the new German ship, the Kaiser Wilhelm II, already launched, and expected to be ready for service by April of next year, surpasses all other German ships in dimensions, and exceeds even the Oceanic in length, although not in displacement. The higher powering of the Kaiser Wilhelm II is expected to give her still greater speed than her predecessors, and thus the advance in size and speed goes on.

The latest additions to the British fleet of first-class Atlantic liners, so far as high speed is concerned, are the Campania and Lucania, and these vessels are now nine years old, while the Oceanic made no attempt to claim maximum speed, being intended rather for comfort and capacity. Naturally there must be some reason for this apparent apathy on the part of the British lines, and this reason is aptly expressed by *Engineering* in the statement that "excessive speed, which means enormous first cost, and extravagant running expenses, does not pay."

As a consequence of the above view of the question, the latter examples of British shipbuilding have been in the class of large vessels, of moderate powering and speed, but of profitable character both for merchandise and passenger traffic. Thus the Celtic, of 700 feet in length, and a heavier displacement than even the Oceanic, is a recent exponent of British construction, while the Saxonia and Ivernia are the successors of the Campania and Lucania in the service of the Cunard line, and others of similar dimensions and speed might be mentioned. That these are good ships and profitable investments cannot be denied, but it must be admitted that they are not to be classed as modern first-class liners. Practically they constitute a class by themselves, a class in which Germany also has some excellent examples, notably the Pennsylvania and her sister ships of the Hamburg-American line. It is not to be admitted, however, that the faster vessels do not pay. The Kaiser Wilhelm der Grosse, the Deutschland, and the Kronprinz Wilhelm are always crowded during the season, and even at other times in the year fully 75 per cent. of the accommodations are used, although high prices are charged at all times. It is claimed that the German high-speed liners have more than paid their way on every trip, without any government subvention beyond the ordinary mail freight fixed on a basis common to all nations.

It is interesting, from an engineering standpoint, to note that the recent success of Germany in shipbuilding is not due to any advance in construction over British practice, nor to any reduction in cost of build-

ing. There is no practical difference in the design either of hull or machinery between first-class vessels of British and German construction. The German vessels are faster because they are more heavily powered for their displacement, and the rules which have been followed in their proportions are identical with those adopted in Great Britain. If British lines would order vessels of similar character and speed from British builders there would not be the slightest difficulty in having the orders filled at similar prices. It is wholly a matter of policy, not of shipbuilding. Says *Engineering:*

"The premier position in the North Atlantic trade has been wrested from us largely by the enterprise of the German shipowners, rather than by the superiority of her naval architects or the greater skill of her marine engineers. The management of the German shipping business has been admirable. The companies have had the courage to build vessels of the highest speed, and they have run them with punctuality not second to that observed on British lines. By attention to passengers' needs, by the politeness of their servants, they have gained the good will of even those belonging to the nationality they have supplanted. Their ships are managed like a good hotel, in which the comfort and happiness of the passengers is considered as well as their safety. In fact, each person who travels recognizes that he is looked on, not simply as a unit of passenger complement—a parcel of live freight—but as a guest whose pleasure is worthy of consideration."

THE REGULATION OF ENGINEERING PRACTICE.

THE PROPOSED LEGISLATIVE CONTROL OF THE PRACTICE OF CIVIL ENGINEERING IN THE UNITED STATES.

An Interesting Society Report.

AT the recent meeting of the American Society of Civil Engineers at Washington there was an interesting report presented by a committee which had been appointed to examine into the advisability of regulating the practice of civil engineering, and from the *Proceedings* of the society we make some abstracts.

This question of limiting the practice of engineering by some kind of restriction, legal or otherwise, is one which crops up repeatedly, both in the professional societies and elsewhere, but until now it has not been presented in such a definite form at a professional session, and hence the present occasion is interesting from the manner in which it has enabled eminent engineers to express their opinions.

The committee very properly included in its report the result of an investigation into the practice of other countries than the United States, since it was found that no states in the Union have enacted any laws upon the subject. In Canada it was found that enactments have been passed in the provinces of Quebec and Manitoba, these requiring membership in the Canadian Society of Civil Engineers as a qualification for practice, or, in the case of the latter province, unless the individual shall have had the degree of Civil Engineer conferred upon him by some institution of learning duly authorized to do so. The fact that this legislation practically placed the control of the Society, so far as its qualifications for membership are concerned, into the hands of the legislative body was a feature not to be overlooked. As a matter of fact these Canadian enactments have not been enforced, and are practically ignored.

In Mexico engineers are required to be licensed, after a professional training at Government schools, while in Europe no provision was found to exist. This latter statement must be understood not to include Russia, since the practice of engineering in the Russian Empire is prohibited to any but those duly authorized by the government. The correspondence of the committee with engineers in England, France, and Germany, indicates that legal regulations were there considered undesirable.

The analogy between the practice of the professions of law and of medicine was considered, and while this forms the principal precedent for the proposition to impose legislative restriction upon the practice of

engineering, it was evident that essential differences exist. The protection of life and health are intimately connected with the regulation of the practice of medicine, while the attorney is theoretically an officer of the court, and as such a part of the legal machinery. A closer analogy is found in the existence of legislation to regulate the practice of architecture in several states, notably in Illinois, where the operation of the law has been found satisfactory, according to Professor Ricker.

Nevertheless the agitation for some action in connection with the practice of civil engineering has shown that very many of the prominent members of the profession are opposed to restrictive regulation. This absence of unanimity on the part of the profession renders it difficult for any desirable legislation to be secured, and even if this difficulty did not present itself, other obstacles appear. Among these may be mentioned the wide scope of civil engineering and the difficulty of defining its limitations; also the great difficulty of securing general legislation in all the states.

Unless the whole field of engineering could be covered, throughout the country, the desired result could not be obtained, even if the entire body of the profession desired it. These reasons, if no others existed, sufficiently explain the fact that the committee recommended that no action be taken by the society, and since the report was accepted, the question is disposed of for the present. At the same time it is interesting to consider here for a moment whether such action as restrictive legislation would be desirable even if it could be had for the asking. To make membership in the American Society of Civil Engineers a requisite for practice would really result in placing the control of membership qualifications in the hands of the state legislature, a condition which it is hardly to be imagined would be acceptable to that worthy society. To require the signature of a titled and licensed engineer upon all drawings and specifications would only be to invite an imitation of the practice in Mexico, where a titled but impecunious engineer can be hired to sit in the back office and lend the use of his name to beat the law. The whole matter is one which can be well left to take care of itself. Indeed it is taking care of itself very well at the present time. There has been no serious evidence of danger or loss to the public by reason of the irresponsible performances of a wild horde of incompetent engineers. It is altogether possible that inspection would reveal more shyster lawyers and quack doctors than defective engineers, so that legislation may not be the panacea after all. Really the committee did wisely in making its recommendation, and the society did well to accept the report, and we may hope that the resurrection of the question may now be long deferred, if not omitted altogether.

THE ENGINES OF THE GLASGOW TRAMWAYS.

OFFICIAL DATA AND RESULTS OF IMPORTANT TRIALS OF BRITISH AND AMERICAN ENGINES IN IDENTICAL SERVICE.

Abstract of Prof. Barr's Report.

THE controversy which occurred about three years ago upon the question of the selection of the steam engines for the Glasgow tramway system will be remembered by engineers both in England and America, and hence the report of Professor Barr upon the tests which he has made upon the completed machinery is a matter of much interest. It will be remembered that as a result of the controversy the order for the engines was divided. There are four large engines of 4,000 horse power each, and of these two were built by Messrs. E. P. Allis & Co., of Milwaukee and two by Messrs. Musgrave & Co., of Glasgow. The general dimensions of the engines were recommended by Mr. Parshall, the consulting engineer of the company, and conformed closely to the existing practice of Messrs. Allis, but in certain particulars, notably in the diameter of the shaft, the proportions were considered excessive by British engine builders. Nevertheless Mr. Parshall's general proportions were followed by both builders, and the tests made by Professor Barr, as reported in a recent issue of *Engineering*,

show the excellent results attained by both builders.

This the Allis engines gave a steam consumption of 12.2 pounds per indicated horse power per hour, while the Musgrave engines did nearly as well, namely, 13.4 pounds. The mechanical efficiency of both engines was most excellent, being about 96 per cent. in both instances.

The most interesting thing about the matter is the manner in which the proportions specified by Mr. Parshall worked out in practice. Although these were considered excessive by British engineers generally they have been shown to be none to great in practice, and as time passes it will doubtless become apparent that the large shafts and bearings will have an important influence upon the continued satisfactory operation not only of the engines but of the generators with which they are connected.

An interesting feature in connection with the contracts is the fact that the American engines were delivered a month ahead of the contract time, and, had they not been ready for work as soon as they were, there might have been no electric tramway service during the Glasgow exhibition. The Musgrave engines, although finally put into satisfactory service, encountered some preliminary difficulties which, while not important in themselves, would have delayed the service of the Corporation had the Allis engines not been ready and operative.

It would be a great mistake to construe the results of this Glasgow business into a national matter, and to use it as a comparison between British and American practice. The engineering world is growing altogether too broad to accept the same limits as those covered by political boundaries, and engineers of the better class are above such limitations. The real facts in the case are simply those which might be gathered from the results of experience. Because of the greater ease with which electric tramway privileges have been obtained in the United States, the development of electric traction has obtained a good lead there over that possible under the unfortunate restrictions in the United Kingdom. As a result a far greater degree of experience has been obtainable in America, and both Messrs. Allis and Mr. Parshall have profited thereby. The conditions differ materially from those obtaining either in marine or general stationary practice, and while it is not mantained that the American practice is necessarily the best, it has at least the benefit of greater experience, experience gained under the most severe and stringent requirements to be found anywhere.

LIQUID FUEL FOR STEAMSHIPS.

PRACTICAL EXPERIENCE WITH RUSSIAN, AMERICAN, AND BORNEO PETROLEUM UNDER MARINE BOILERS—FUEL, METHODS, AND APPARATUS.

Institution of Mechanical Engineers.

ALTHOUGH the advantages of petroleum and its residues as a steam making fuel have long been known, there has recently appeared a great interest in the subject, partly owing to the development of new oil fields, and partly in the natural development of steam engineering. The present state of the question has been ably set forth in a paper presented before the Institution of Mechanical Engineers by Mr. E. L. Orde, of Newcastle-on-Tyne, whose previous discussion of the subject before the North East Coast Institution of Engineers and Shipbuilders we reviewed in these columns about two years ago.

Since that time the great petroleum developments of the Beaumont district in Texas have been made, while the progress in the satisfactory use of Russian fuel oil for steamships and locomotives has been most encouraging.

The present state of the supply question is discussed by Mr. Orde, who believes that commercial enterprise now only needs the stimulus of demand to organize distributing stations, while the methods of consumption on the large scale need only the attention of engineers for their development.

Mr. Orde divides the subject into four divisions: the fuel itself, the conditions governing its combustion, the apparatus employed, and the results obtained.

With the chemical composition of the

various oils the engineer is not so deeply interested as he is in the calorific value and in the behaviour during combustion. The fuel oils available for steam making are those from Borneo, Texas, Caucasus, and Burmah, the composition being in all cases about 86 per cent. carbon and 12 per cent. hydrogen, and the calorific value about 19,000 British thermal units.

Although the oil is generally used in the crude form as fuel, there are certain phenomena observed in the process of distillation which are of interest in connection with its combustion in the boiler furnace. The processes of distillation are two in number known as the "cracking process" and the steam process.

"The 'cracking' process consists in distilling over the lighter oils at temperatures above those at which they would boil under normal conditions. This is effected either by allowing the products of the distillation to condense and fall back into the contents of the still, or by distilling under pressure. The effect of the process is to decompose the heavier oils remaining in the still and materially decrease their specific gravity. The oil resulting from this process becomes more homogeneous in its composition than before; but if the temperature in the still reaches too high a point, solid carbon is deposited in the form of coke. These deposits of solid carbon, unless careful attention is paid both to the temperature to which the still is exposed and to its design, form a large proportion of the residuum after the lighter oils have been taken off; and continuous distillation on the "cracking" principle seems to be impossible owing to the rapid increase in quantity; but in the presence of steam, on the contrary, it appears to be possible to distil practically the whole of the crude product. One explanation of this phenomenon that has been given is that steam has the property of lowering the boiling points of the hydrocarbons with which it is brought in contact, and therefore allows them to volatilize at temperatures below those at which the cracking process sets in. Superheated steam is generally used in order to attain the temperature required for distillation, which reaches 550 to 600 deg. Fahr. in many cases. Air does not possess this solvent property, nor is it so convenient a vehicle for the heat required in the process of distillation. This part of the subject has been dealt with at some length, as the process of presenting the liquid fuel in boiler furnaces in the most suitable conditions for combustion is in many respects an analogous one. Before complete combustion can take place, the fuel must pass from the liquid to the vapour form; and it is obvious that the most successful apparatus must be that which accomplishes this object with the smallest expenditure of heat."

An important point in connection with the successful use of liquid fuel is the avoidance of water in the oil. The injurious action of water is twofold; it not only causes an actual loss of heat, but it interferes with the conditions necessary for perfect combustion.

Even if the amount of water present is not sufficient to extinguish the flame, it reduces the temperature and thus renders the flame longer, with the result of moving the point of highest temperature further into the furnace. This has the effect of rendering a large portion of the heating surface of the furnace useless, and of raising the temperature of the combustion chamber to a point which may injure the material, while it also causes a large part of the combustion to take place in the smoke box and funnel.

"The conditions that attend and the reactions that take place in burning liquid fuel in boiler furnaces present a problem which has apparently not received the attention which it deserves. Petroleum vapour depends entirely on temperature and it is therefore almost impossible to collect samples when actually burning it in a furnace. It seems obvious that the first effect of the furnace heat on the petroleum spray is to liberate hydrocarbon vapours, and to ignite them on the outer surface of the jet. The ignition raises the temperature of the whole of the jet, and probably dissociates some at least of the hydro-carbon vapours into carbon monoxide and hydrogen. In what form the undissociated hydrocarbon vapours burn it is difficult to conjecture, but the appearance of the flames suggests that acetylene is present. This might conceivably arise from the reaction $CH_4+CO=H_2O+C_2H_2$. As the temperature of the flame rises, the hydro-carbons are probably all dissociated and burn as CO and H to CO_2 and H_2O without further change.

When the conditions are satisfactory, the flames are opaque and dazzling white in colour for a distance of some 6 in. from the nozzle of the burner, become semi-transparent, and almost violet in colour at the middle of their length, and shade into red at the end. In burning oil which is mixed with water the combustion is incomplete, the violet colour never appears, and the end of the flame is dark red and fringed with smoke. In some cases, where water is present in comparatively small quantities, the end of the flame is white and presents the appearance of acetylene, which may arise from want of sufficient heat in the flame to decompose the hydrocarbons. This has been observed, when, although no smoke was formed, and the air supply was not more than 20 per cent. above what is chemically necessary for the fuel, the evaporative performance of the boiler was poor, which confirms the existence of a low furnace temperature."

The burners used with liquid fuel are of three types, although many varieties have been devised. Those using a mechanical spray depend upon the pressure and form of nozzle to break up the oil into a spray sufficiently fine to render it inflammable. Jet burners use the atomizing action of a jet of steam or compressed air to deliver the fuel into the furnace in the necessary finely divided condition, while vapor burners require the fuel to be volatilized before it is admitted to the furnace in the form of vapor. The first and third types are but little used, and by far the greater number of successful burners in use are operated by means of jets of superheated steam or compressed air. In general construction these resemble the well-known Giffard injector for boiler feeding, the steam, highly superheated, driving the oil into the furnace in the best possible form for effective combustion.

In the recent experiments in the United States navy, the engineers in charge preferred the air jet, but also provided steam jets for reserve in case of failure of the air supply.

The evaporative value of fuel oil under steam boilers is naturally dependent in some measure upon the general arrangement of the apparatus, but the results of a number of tests have shown that in general the fuel consumption in favor of liquid fuel as compared with coal ranges from 25 to 35 per cent. There appears to be no doubt that the full difference between the calorific values of the two fuels can be secured in marine practice at such rates of evaporation as are usually obtained in the boilers of vessels of the merchant marine. The problem undoubtedly becomes more complex when the higher rates of evaporation, such as are required in war vessels are considered, but there is little doubt that the problem is quite within the solution of engineering skill.

The experiments in the United States navy, above referred to, brought out the important fact that practically no residue was found in the tubes of the boilers after a run from Honolulu to San Francisco. The great advantage of the maintenance of effective heating surface is well worthy of consideration, while the greater ease of firing needs only to be mentioned to be appreciated.

MECHANICAL APPLIANCES IN COAL MINING.

METHODS AND MACHINERY UPON THE USE OF WHICH THE FUTURE CONTROL OF THE COAL TRADE OF GREAT BRITAIN DEPENDS.

Paper before the Institution of Mechanical Engineers.

AMONG the papers presented at the recent meeting of the Institution of Mechanical Engineers at Newcastle-on-Tyne was one by Mr. R. H. Wainford upon the employment of mechanical appliances in coal mining and in view of the importance of the subject some abstracts are here made. As Mr. Wainford truly remarks, the getting of coal is not only in itself the most important industry in the country, but it is the one upon which nearly all other great industries depend, and hence it demands the most serious consideration. For this reason the saving in the initial stage of operations in the cost of coal is a boon, not only to the mine, but to those who are dependent upon its produce.

"The advantages gained by mechanical means do not end in the simple reduction in cost of getting—there is also a substantial

gain in having a coal of enhanced value, due to their being a greater percentage of round coal (not so much slack made); by there being a less number of men actually working at the coal face—the most dangerous point in a mine—and consequently a reduction in the number of claims for compensation; and another important factor, that of houses for workmen; in fact, this latter, taken in a broad sense, is capable of repaying capital outlay for plant. From this it is not to be assumed, that all men taken from the face are thrown out of work, but rather, the output of each pit is so much increased that the work of a less dangerous nature will be available for them in the pit, and an outlet will also be found in the iron and steel works, which, it is to be assumed, would have increased business, to the detriment of the imports of iron and steel, and, in fact, of general engineering work. Thus it will be gathered the introduction of mechanical appliances at the coal face does not necessarily mean paying off men, but it does suggest largely increased output, both in the mines and kindred trades. It may be urged still further—it is due to the ironworks and engineers—improved conditions in coal winning should be vigorously pushed forward. The idea of curtailing the output of coal in order that high prices may be maintained is diametrically opposed to the above suggestion—which idea represents one of the many disadvantages of piece work, and when considering mechanical methods it should be prosecuted with the ultimate intention of paying wages by the day or hour and not on tonnage."

In discussing in detail the methods and appliances used in the mechanical mining of coal, Mr. Wainford makes comparison mainly with the devices used on the Continent, although he maintains that there are doubtless machines of British manufacture equally good. Naturally the principle and immediate gain to be expected from the use of undercutting and holing machinery is the economy in labor effected, but there are other elements of saving which must be considered. Among these may be mentioned the gain due to the less amount of slack made by machine cutting over hand holing. The machines generally work under the coal, while the miner holes in the coal, the latter method naturally producing the most slack. It is found that something like 90 per cent. of the coal got by machines will pass over a ⅞ screen mesh, as against 60 per cent. by the hand method, this corresponding to an increase of 6¼d. per ton in the value of the coal. The loss from accidents is also much less with the machines than with hand working, while the gain in actual cost of working is shown to be more than 6½d. per ton, so that an advantage of more than a shilling in the ton may be had by the use of machines.

It is in the working of thin seams, however, that the gain due to cutting machines appears most conspicuously, since it is there that the cost of hand cutting is the greatest. Indeed, for seams which are more than 5 feet thick the advantage of machines is but slight, while the best results have been attained in seams of less than 2 feet thick.

Mr. Wainford describes a number of machines in his paper, these being both of the disk and bar types, the general construction and performance of which are well known. His principal contention is not the advocacy af any particular type of machine, but rather the urging of the machine as against the man, wherever possible.

"The question of determining relative results of hand work versus power is complex however, almost impossible, as singular cases would have to be taken, which, when demonstrated, will prove next to nothing. However, there is a substantial gain to be effected in this direction.

"Figures are reputed to have the quality of proving almost any set idea; if they fail, the suggestion of a local engineer might be quoted. He remarked, to prove the real value of coal-cutting and drilling machines, a number of collieries should combine together, and after selecting the most suitable type to meet each particular case, put in one cutter, with other mechanical tools to work a district; that is, each mine should set apart a district to be worked exclusively under mechanical methods, say for a year, each pit working independently, with a view to ultimately, after the expiration of the term, comparing notes and reporting results. If such a plan was possible, the idea could be effectively settled for or against, and the results would show fully the advantages which are only set down in this paper as being more than possible."

There is one point which, while not advanced by Mr. Wainford, may be not without value to mine operators, namely the greater freedom from labor difficulties when machines are used as compared with the exclusive use of hand labor. Strikes are far less likely to occur when the most difficult work can be performed by machines which may in case of emergency be operated by men more readily obtained than formerly, while the very fact that fewer men may be required must have its bearing on the frequency of labor difficulties.

Too much cannot be said on this subject of coal cutting machinery, for the all-important reason of its bearing such a serious and far-reaching effect upon the kindred to mining trades, as well as upon the prosperity and future of this country; and if real and tangible results have not been proved beyond doubt, at all events Mr. Wainford has opened out to some extent a question which must ultimately be taken up vigorously; and whatever may be the future of mechanical coal-cutters and other appliances in mines, there is the assuring fact to be remembered in considering it, that there is not a single drawback to its adaptation from the point of view of safety to life or the science of mining engineering. From the practical point of view some objections to machine practice occur; they present themselves differently in each mining district, discussion may indicate them variously. One of the chief objections to the system is the difficulty in finding men to attend the machines, possessing sufficient mechanical skill and pit experience to enable them to cope with contingencies at the face as they are met; but this hardly reflects discredit upon the mechanical methods directly. Miners con readily apply themselves if dealt with with tact and encouraged in the work. At some places machine methods have recorded a failure, traceable very often to the plant being either badly designed or lacking the necessary power, but most often to the system being taken up in a desultory manner, for it seldom happens that a new idea does not meet serious difficulties, due to prejudice, either on the part of the management or the men, or both.

A STUDY OF POWER GAS.

THE GENERATION OF MOTIVE POWER IN INTERNAL-COMBUSTION ENGINES AND THE UTILIZATION OF WASTE FURNACE GASES.

Société des Ingénieurs Civils de France.

ABOUT three years ago there was presented before the Société des Ingénieurs Civils de France a very complete paper by the well-known expert, M. Lencauchez, upon the generation of gas suitable for direct use in internal combustion motors. At that time he considered producer gas, wood gas made by the Riché process, and water gas, and showed the greater economy attained by the use of producer gas. This paper was reviewed in these columns in the issue for September, 1899, shortly after its presentation before the Société in Paris. We now have a second paper upon the same subject, prepared by the same engineer, after the lapse of three years in which material strides have been made in the development of the subject. From this second paper by M. Lencauchez, published in the *Mémoirs de la Société Ingenieurs Civils de France*, we make some abstracts, giving a general idea of the progress which has been made in the generation of motive power direct from fuel using the product in the cylinder of the engine, without the intervention of any process of steam making.

The advantages of gaseous fuel are many, but the considerations which may lead to its adoption vary greatly with local conditions. In all cases there is a material economy from its use, since the thermal efficiency of even a small gas engine is much higher than that of the best steam engines. Questions of cleanliness, freedom from smoke, and general convenience sometime outweigh material differences in cost. In other instances the gas is a waste product from metallurgical operations, notably from blast furnaces in iron manufacture, while in others fuels altogether unsuited for steam making may be utilized in the gas producer.

In discussing the gas producer, M. Len-

cauchez reviews the earlier types, originally designed for the generation of gas for use in metallurgical furnaces, and then proceeds to those used for the production of power gas. While there is no fundamental difference in principle between the more recent producers and the earlier ones the improvements which have been made are important, affecting as they do both the more convenient operation of the apparatus, and in several instances, in the utilization of valuable by-products.

Originally a gas producer was simply a shaft furnace of moderate depth, in which the thickness of the fuel bed, and the limited supply of air caused but a partial combustion to take place, the result being a gaseous product consisting principally of carbonic oxide mixed with the excess of nitrogen from the air supplied for combustion. When a certain proportion of steam is blown through the incandescent fuel, a water-gas is produced, containing a varying proportion of hydrogen, and in all the varieties of fuel gas there are small amounts of hydrocarbons present, but the principal fuel elements present are carbonic oxide and hydrogen, and the calorific value of such gases range from about 100 thermal units per cubic foot for lean producer gas or waste gases from the blast furnace, to 135 thermal units for producer gas from coke, or 300 units for good water gas.

So far as thermal economy goes, it has been found that with properly constructed engines the efficiency with the very lean gas is as high, if not higher than with the richer gas, but naturally a larger engine is required to produce a given amount of power.

In the design of gas producers the principal difficulty is found in the tendency of the non-combustible portion of the fuel to form clinker, to clog or choke up the barrel of the producer. Various devices have been made to prevent this action or to render the breaking up of the clinker less difficult. In the early producers the operation of "barring" was resorted to, this consisting in the introduction of long bars through holes in the sides of the producer, and the breaking up of the obstructions by manual effort. This method, while very laborious, was also but partially effective, and frequently resulted in the formation of holes through the fuel bed through which the air passed, causing great irregularities in the production of gas. Various forms of movable and revolving grates have also been used, the aim of some of these being to keep the fuel in constant agitation, thus preventing the agglomeration of the clinker into masses. The blast furnace, while intended for altogether a different operation, solves the question of clinkering most effectively. By the use of a limestone flux, and the maintenance of a high temperature in the lower portion of a very high furnace, the noncombustible portion of the fuel, together with the non-metallic portion of the ore, is fused to a liquid slag, and drawn off before solidification, while the gas burned to carbonic acid in the lower portion of the furnace, unites with additional carbon in its passage upwards, and the ultimate gaseous product of the furnace is practically identical in composition and thermal value with that of the gas producer.

The principal questions of immediate interest in connection with the paper of M. Lencauchez are those relating to the purification of the gas from dust and the condensation and separation of the valuable by-products. In the Mond process a semi-water gas is produced, while at the same time a valuable by-product in the form of sulphate of ammonia is secured.

The removal of the dust from blast furnace gases constitutes a most important factor in their utilization directly in the cylinders of gas engines, and M. Lencauchez describes several arrangements for scrubbing and washing the gas to free it from particles which might cut or injure the cylinder. The heavier particles may be separated by a proper arrangement of flues giving opportunity for settlement, while the fine dust is removed by washing. This is best effected by passing the gas through scrubbing towers containing coke or woody fibre saturated with water from a spraying apparatus, the gas moving in the opposite direction to the water. The gas produced by different furnaces varies greatly, and in some instances no purification is necessary, since experience has shown that the very fine dust is passed through the cylinders of large engines without producing any injurious effects, either upon the piston and bore or upon the valves.

EARTHQUAKE RECORDERS AND BRIDGE VIBRATIONS.

THE EMPLOYMENT OF THE SEISMOGRAPH TO RECORD THE INFLUENCE OF MOVING LOADS UPON RAILWAY BRIDGES.

Investigations of a Japanese Engineer.

THE publications of the Imperial Earthquake Investigation Committee of Japan have been highly valued for their contributions to the study of seismoiogy, but the latest of these publications is of especial interest to engineers because it relates to the vibrations of engineering structures rather than to the crust of the earth itself.

The very delicate instruments known as seismographs are intended to trace curves showing vibrations in any direction and thus preserve records of earthquakes too slight to be generally perceived. Various forms of construction have been used for these instruments, but the principle involved is always that of the inertia of heavy masses freely suspended, and permitting the recording surface to move beneath them with the vibrations. The delicacy of such seismometers is very great, and their use in specially maintained observatories has furnished much information as to the time, direction, and duration of earthquake shocks in various parts of the world.

Mr. F. Omori, a Japanese engineer and a member of the Imperial Earthquake Investigation Committee, has taken advantage of his familiarity with seismological instruments to use them for the study of the deflections and vibrations of railway bridges during the passage of trains, and in the publication of the Committee above referred to the results of his investigations are given at length.

As Mr. Omori remarks, such experiments furnish information of two different kinds. By taking vibration records from a number of differently constructed bridges under similar conditions, valuable comparative information may be obtained as to the best forms for strength and for economy of material. By taking a continuous series of observations of any given bridge at regular intervals, the variations in strength for various loads and for the lapse of time are recorded. Both of these results may be made of much importance, the latter, especially, might give warning of the gradual weakening of a bridge in time to prevent serious disaster.

The passage of a moving load over a bridge causes two distinct actions, although these are not always clearly separated. The mere presence of the load upon the span causes a certain bending, and if the load is permitted to remain standing in the middle of the span the amount of depression may be measured very accurately. This is called the *deflection* of the span. The action of the moving load, approaching, traversing, and leaving the span, also sets up *vibrations*, vertical, transverse, and longitudinal, the period and amplitude of these vibrations depending upon the speed with which the load moves. Hence the amount of bending observed during the passage of a train or other load is the sum of the vertical vibration and the deflection due to the dead load. The deflection can always be provided for in the original design of the bridge, and can in many cases be computed beforehand, or kept below certain prescribed limits; the vibrations are not so simply handled. Nevertheless they form a very important portion of the duty which is demanded of a bridge, and with the increase in weights and speeds every facility which is afforded for the determination of the nature and effects of vibration is to be encouraged.

Mr. Omori describes two forms of seismometer which he has used in his investigations upon Japanese bridges. One of these, the deflectometer, is similar to the vertical-motion seismograph of Gray and Ewing, modified so as to prolong its period of free oscillation, the deflection being measured as a very slow vertical vibration. The slowness of the period, being about twice the time required for the passage of the train over the bridge renders the instrument practically insensitive to the more rapid vibrations, hence it records the deflection alone.

The second instrument, the vibration measurer resembles closely a seismograph as arranged for the measurement of strong earthquakes. This is provided with hori-

zontal pendulums as well as a vertical motion measurer, so that the movements in all three directions may be recorded. By giving the pendulums sufficient inertia and a period of oscillation altogether distinct from the possible vibrations of the bridge it is rendered easy to distinguish the real bridge vibrations from the instrumental oscillations, if there be any.

These instruments must be very rigidly attached to the bridge, preferably upon one of the bottom chords at the middle of the span, in order that the maximum effect may be noted. In Mr. Omori's paper a number of the records made by him in the course of his investigations of Japanese bridges are given, but while these are very interesting as illustrating the operation of the apparatus they are of small value as engineering data because the structures were old and of obsolete types. The general typical character of a bridge vibration, however, may be clearly deduced from the records.

The vibratory motion of a bridge consists generally of three parts: the preliminary portion, in which the motion is small and occurs with the approach of the train to the girder; this is followed by the principal portion, in which the motion is most active and generally coincides with the passage of the train or engine over the girder under experiment; after which comes the end portion, in which the motion is small, being the residual vibrations continued for a certain interval of time after the train has passed over the girder. The vertical, transverse, or longitudinal motion of a bridge girder consists in general, of the fundamental vibrations of a period which is proper to the girder itself, just as a violin string or tuning fork has its own note. Besides these there are extremely quick and usually much smaller movements, which are probably due to the vibrations of the individual members of the girder, and which may be termed micro-vibrations.

When it is realized that in nearly every case a bridge failure occurs from some other cause than excessive statical loading, it must be admitted that any method of study or research which furnishes information as to the other and powerful destructive forces in action should be welcomed. It is well known that long continued and excessive vibrations have weakening effects upon materials and structures, and the scientific and continued use of the seismograph, as indicated by Mr. Omori may lead to the determination of data by which these injurious forces may best be resisted.

THE ELASTIC LIMIT OF METALS.

THE APPLICATION OF OPTICAL INSPECTION TO MATERIALS UNDER TENSION AND COMPRESSION IN THE TESTING MACHINE.

M. Ch. Fremont, in Comptes Rendus.

IN a recent paper presented before the French Academy, and published in Comptes Rendus, M. Ch. Fremont, well-known for his experimental researches on the strength of materials, discussed the peculiar behaviour of metals under compression, considering apparent variations in the limit of elasticity.

Ordinarily the elastic limit, whether in tension or compression, is best determined from the diagram traced by some form of automatic recording device, either forming a part of the testing machine, or attached as an auxiliary apparatus, and it is generally expressed in kilogrammes per square millimetre, or pounds per square inch of the original area of cross section of the test piece. As a result of extended experience in connection with compression tests, however, Mr. Fremont has observed great variations in the elastic limit for specimens which should be practically identical. These variations can hardly be due to imperfections in the precision of the testing machines, since they appear in the work of the most carefully made apparatus, after thorough calibration and accurate adjustment.

Thus, for a steel of which the elastic limit was actually 24 kilogrammes per square millimetre, compression tests gave values of 8.55, 11.56, 13.9, 14.10, and 15.7 kilogrammes. M. Fremont suspected these variations to be due, in part at least, to the impossibility of applying the compressive force in a direct line through the test piece between the heads of the machine, the compression

taking place more or less obliquely. In order to determine the manner in which the force really acted in the metal, it is only necessary to give the surface of the test piece a high polish. If the polishing is imperfectly done it will limit the observations to the appearance of deformations of greater magnitude than the inequalities in the surface, hence it is important that the metal be most highly polished. Under such conditions, when the piece is under compressive test, it is possible to observe, at the precise moment when the elastic limit is reached, a dulling of the polished surface indicating, more or less clearly, the direction of the line along which the maximum compression is being exerted. This dulling of the surface is the result of the molecular change which occurs at the moment of passing the elastic limit, and hence it appears that the limit has not been attained in those portions which retain their original polish, so that the limit of the entire specimen is not reached at one time, and a diagram obtained under such conditions cannot be considered as expressing the true resistance of the test piece. The irregular dulling of the polished surface, often in spots and discontinuous areas, while only a surface indication, may be taken as representing a corresponding irregularity in the interior of the piece. There must, therefore, exist portions of the material which are subjected to stresses below the elastic limit, while other portions of the same piece have that limit already exceeded.

Having observed these facts, M. Fremont proceeded to examine methods for the elimination of uncertainty in such an important question in connection with the resistance of materials. Assuming the inequality to be due to the difficulty in adjusting the machine so that the pressure should pass axially through the test piece, he modified the shape of the piece so that the pressure should first be localized in the axis of figure and then uniformly distributed over the whole area. This was accomplished by the use of specimens made in the form of a truncated cone or a truncated pyramid, the truncated portion being terminated in a cylinder of smaller section than the cone. The irregularities in deformation are thus localized in the weakest portion of the test piece, and from thence propagated to the polished surface for observation as before. An examination of the dulled surfaces of a polished test piece under the microscope, showed that two different types of deformation appear at the elastic limit, this being true for tests under tension as well as under compression. In the first type the deformation is effected suddenly, and there is a distinct line of demarcation between the polished and dulled portions of the surface. This is an action typical of steel. In the second type the deformation appears to occur more gradually, and the limit of the dulled portion of the surface is not indicated by a line, but fades off gradually. In the first type, successive determinations of the elastic limit of similar specimens closely approach each other, while in the second the limit can be only approximately determined.

Apart from the interest which attaches to these researches in respect to the advancement of precise testing, they serve to emphasize the importance of applying compression loads axially in practical construction, or where such axial loading is not possible, the importance of making suitable allowance for reduction in strength is indicated. Thus all the formulas and tables for the supporting strength of pillars, whether of steel, cast iron, or wood, are based upon central axial loading, a condition which is rarely, if ever, attained in actual construction. Indeed, the present practice in tall building construction, especially when cast iron columns are used, is to throw a large portion of the load upon brackets attached to the sides of the pillars in such a manner as to produce eccentric and bending loads altogether indeterminate in magnitude or direction, and invariably greater and less effectively resisted than the computations consider. If this practice is found constructively so desirable that it should be continued, the proper plan should be to subject such columns to thorough testing, not with axial loads, but with eccentric loads as similar as possible to those applied in actual practice. The information thus acquired might be used with confidence by contractors, builders, and engineers, who are now working largely in the dark as to the real strength, or weakness, of the members upon which they place such indeterminate burdens.

EXPERIMENTAL AERONAUTICS.

THE PROJECT FOR CROSSING THE DESERT OF SAHARA WITH A BALLOON—A MECHANICAL AUTOMATIC EXPLORING EXPEDITION.

Experiments of the French War Department.

FROM the original experiments of Montgolfier down to the present time the subject of aeronautics has always been popular in France, and the latest project there developed is one for the construction of a balloon to cross the desert of Sahara. This scheme includes a number of original ideas, and from an account in a recent issue of *La Revue Technique* we make some abstracts.

The idea, which is to be executed under the direction of the French War Department, is intended primarily to determine the practicability of crossing the desert in a balloon in safety, and secondarily, to secure as much information as possible about the route traversed. A number of *ballons sondés* have been sent up in France during the past few years, these being small balloons, without occupants, containing only meteorological instruments, and instructions to the finder as to the manner of reporting the arrival of the balloon at any destination.

The balloon now under construction for the Sahara trip is a repetition of these experiments on a much larger scale. It is to carry no human passengers; but in order to test the habitability of the region traversed there will be six pigeons placed in a cage in the car. An extensive equipment of scientific apparatus will be carried, and if the experiment is brought to a successful conclusion the result will be the addition of some interesting items to our stock of scientific data, and possibly an impetus may be given to future attempts on a still more ambitious scale.

The description given in *La Revue Technique* consists mainly of the specifications according to which the balloon is to be constructed and of the equipment with which it is to be supplied. The plans call for a spherical balloon, 12.4 metres in diameter (about 40 feet) made of cotton cloth, varnished, and filled with illuminating gas.

Since the balloon is to be without human passengers it is necessary that it be automatically controlled, and it is in this respect that much ingenuity has been shown in the design. As it is expected that the journey may last four or five days, provision must be made for the regulation of the ballast to provide for the gradual loss of gas. This has been done by the use of water-ballast, there being a tank containing 700 litres of water, suspended below the car in which the pigeons and the instruments are placed. In the bottom of the water tank is a valve arranged with a spring which acts to lift it open, and connected by means of a wire 12 metres in length with a steel ball of 20 kilogrammes weight. The weight of the ball is sufficient to overcome the force of the spring, and hence the valve will be kept closed so long the ball hangs freely in the air. Whenever the balloon, from loss of gas descends within 12 metres of the ground, the ball will touch and the valve being opened a portion of the water ballast will escape and the reduction in load will cause the balloon to rise and proceed.

The apparatus carried by the balloon is to consist of the usual meteorological instruments, recording barometer, thermometer, and hygrometer, etc., except that the clockwork of all of them is to be arranged to operate for five days. In addition to these there is to be carried a specially designed photographic apparatus. This camera is made somewhat on the principle of a cinematograph in that it contains a long strip film, but the photographs, instead of being taken at very close intervals, will be controlled by clockwork, an exposure being made every fifteen minutes. While doubtless many of the exposures will be worthless, there is a possibility that some very interesting pictures may be made, and the result of this portion of the expedition will be awaited with much interest.

A supply of food and water is to be provided for the pigeons, and an arrangement for their release is provided, this to come into action when the balloon itself touches the ground.

The specifications contain a detailed description of the construction of the various

parts of the balloon, its suspension, inflation, and launching, as well as of the smaller balloon which is to accompany it and the 36 small paper balloons which are to be sent off at the same time, and the details of the project appear to have been very completely worked out. The balloon is to bear an inscription in French, Arabic, and English offering rewards for the safe delivery of the car and its contents.

The real value of such an experiment is difficult to determine. Doubtless there is a probability that the balloon will drift out of its course and never be heard from until, after a long interval some traces of it may be found. Assuming, however, that it does cross the desert safely, and its contents are returned to civilization, the information to be gained cannot be very great. The direction of drift must be largely depended upon transient air currents and thus give no clue as to the course of subsequent trips. The meteorological records may be of value, especially as to temperature and moisture, as well as furnishing information concerning the behaviour of recording instruments for longer periods than have hitherto been used in such experiments. As already remarked, the greatest novelty may be found in the automatic photographic apparatus, but this remains to be seen.

Even if successful, it is doubtful if such an experiment would warrant an atempt to repeat the trip with a balloon containing human passengers. Certainly if such an experiment should be made, some form of dirigible balloon should be used, and by carrying sufficient propelling power the direction of the journey might be controlled as well as the speed. The results of the experiment will be awaited with interest, even though the promised returns to science be small, and with this preliminary trial, at least, no lives are to be risked, while there is a possibility that something may be learned.

THE CORROSION OF PIPES BY STRAY CURRENTS.

HOW THE DESTRUCTIVE ACTION OF THE RETURN CURRENT UPON GAS AND WATER PIPES MAY BE PREVENTED.

A Lecture by James Swinburne.

IT was not long after the introduction of the electric tramway that the effect of the current returned through the rail upon the gas and water pipes buried in the earth was perceived, and although there had been more or less agitation upon the subject the real merits of the question still remain open. In an interesting address recently delivered before the Incorporated Gas Institute, Mr. James Swinburne discusses the subject in a very lucid and interesting manner, and from his remarks we make some abstracts.

In the first place the character of electrolysis should be clearly understood. When an electric current passes from one metallic conductor to another through an intermediate substance, such as liquid or moist earth, there is a corrosive action set up in the metal which the current leaves, just as if the electric current carried away a part of the metal with it. This action does not occur when the current leaves through another metallic conductor, nor is there any action where it enters the second conductor.

Now in the construction of electric tramways it is the practice to take the current from the power house into the car through an overhead wire, and return it through the axle, wheels and rails back to the generators. The feeder wires are carried overhead upon insulators, but the rails are imbedded in the earth. If the rails were absolutely continuous and insulated the entire current would be returned without leakage, but the presence of joints and the absence of insulation change the conditions. Now if there should happen to be a line of gas or water pipe running along in the earth near the line of the rails, as there generally is, the current will find it easy to leave the rail in part and travel along the continuous pipe until it reaches the vicinity of the station.

The result of this action will be the corrosion of the rail at the point where the current leaves it and a corrosion of the pipe at the places where the current leaves it. Corrosion of the rails is a matter which concerns the tramway company, but it is

not so injurious as the corrosion of the pipes, because the latter are soon rendered leaky, with the consequent escape of the water or gas in them. Naturally the greatest corrosion of the pipes is in the vicinity of the electric generating station, where the return current leaves the pipes to get back to the dynamos, but it is distributed along the line for a considerable distance, and in many cases it has done much harm.

Various methods have been considered to prevent this action, but none of them is altogether satisfactory. The only complete method is to provide a separate return wire, with a second trolley pole on every car, none of the current returning through the rail at all. The cost of this is considered prohibitory. It would practically throttle the tramway industry and interfere with transportation to forbid earth returns. At the same time the gas and water companies which were in existence before the tramway companies were thought of have their rights to be considered.

Naturally the first remedy to be tried is the perfecting of the electric bond between the rail joints. If this could be made continuous there would be little inducement for the current to leave the rail and seek a return through the pipes. Various plans have been tried for this purpose. Besides the various forms of flexible bonds, the rails have been electrically welded, or welded and cast by the Goldschmidt process, or joined by pouring fused iron round them from a portable cupola. When, however, the traffic is large, the increase in the return current is such that no amount of bonding will do. In such cases a negative booster has been employed. This device consists of a motor driving a generator so connected as to produce a negative pressure in the circuit, thus taking the current from the rails and returning it to the generator. Sometimes the corrosion may be reduced by connecting the gas and water pipes in the vicinity of the station with the generator by metallic connections, thus allowin the current which may be traversing them to return direct, instead of through the earth.

In spite of all these devices the fact remains that a portion of the current will stray from the rails and in its return may produce electrolytic corrosion in buried pipes to an injurious degree.

"In small towns where there is only one tramway system, the chance of appreciable electrolysis is small. In large towns there are, or soon will be, several tramway systems, and probably some electrical railways. It would be very difficult for a London company to decide who ate their pipes, and still more difficult to bring the crime home by the clumsy and expensive method of arbitration. To make the tramway people liable for any damages is obviously fair, the real difficulty is to carry the matter out. Such a liability is for that reason very serious to the tramway. A small tramway—which we will for this example suppose really innocent—is liable to be mulcted in damages that might ruin it, by a mistake of judgment of an arbitrator, or of experts called before him. This is a very serious liability.

"To sum up there is electrolysis, and your pipes are being eaten; but whether the corrosion is really serious or not can hardly be settled yet. Tramways are increasing in all directions, but they are also being more and more carefully designed. The large systems use lead-covered cables themselves, which are infinitely more easily damaged by electrolysis than gas pipes, because the lead is easily corroded, the conductors are continuous, and the cables are generally near the tramlines. The electrical tramways are thus more likely to damage themselves than their neighbors by any bad design or careless working. It behooves gas and water companies, however, to watch carefully. The question of electrolysis is not really settled. In the course of years we may have more information, and we may then find either that the stray currents are practically harmless, or that new laws have to be made."

In all the instances above noted it is assumed that the tramways are of the overhead trolley type in which the current is taken in through a trolley pole and wheel and returned through the track rails. In the underground trolley, where there are two continuous conductors in a conduit beneath the street, reached through a slot between the rails, no stray currents are to be feared, since the copper return conductor in the conduit offers a far superior return route than can be found in any water pipe.

PRACTICAL EXPERIENCE WITH THE NERNST LAMP.

DURATION, COST, AND ILLUMINATING EFFICIENCY OF THE NEW INCANDESCENT LAMP. THE EXPERIENCE OF USERS AND LIGHTING COMPANIES.

Discussion of the Cincinnati Convention.

WHEN the invention of the new incandescent lamp by Pro. Nernst was announced there were some misgivings as to the practical nature of the invention, but now that sufficient time has elapsed to enable commercial experience to be had it is possible to speak with some confidence as to its performance. There has always been a demand for some form of electric lamp which should have an illuminating power between the arc and the incandescent filament. This demand has been more or less imperfectly met by the use of incandescent lamps in clusters or by the enclosed-arc lamp, but neither of these has proved just what was wanted.

At the recent convention at Cincinnati a topical discussion was held upon the practical experience which various members had had with the Nernst lamp, and from the consensus of opinion thus obtained it appears that the new lamp bids fair to become most useful in certain fields.

It will be remembered that the invention of Professor Nernst consisted in the application of a pencil of earthy oxides as an incandescent material. The glower, as it has been termed, is a non-conductor of electricity when cold, but when heated it permits the passage of the current, at the same time opposing sufficient resistance to become heated to incandescence, and thus furnishing a brilliant light. Since the glower is composed of non-combustible materials no vacuum bulb is required to prevent its combustion, and the glower maintains its brilliancy unimpaired in the open atmosphere so long as it is heated by the passage of the current. In its practical construction the lamp has demanded much ingenuity so far as provision for preliminary heating and regulation were concerned, but these points having been met the question of practical behaviour remained.

From the first the light produced by the Nernst glower has been satisfactory, resembling somewhat the illumination of the Welsbach incandescent gas mantle. The real practical questions were those of cost and durability. Although the glowers are composed of non-combustible material, yet they have a definite working life, and ultimately become disintegrated and useless. The range of this life in working practice has been from 1,300 down to 100 hours.

Usually the lamp is used with an alternating current, and with a frequency of 60 cycles the life is found to be about 800 hours, which is quite as long as can be expected from an ordinary incandescent lamp in a vacuum bulb. With a frequency of 25 cycles the life is about 400 hours, but experiments now being carried on at Niagara are expected to furnish further information on this point.

At the Cincinnati convention opinions were expressed by the representatives of a number of lighting companies, and by far the greater number of these were altogether favorable. So far as the care and attention are concerned, the amount of work closely approximates that required for the arc lamp, except that it does not have to be done so often. Every time a new glower is put in the lamp becomes practically a new one, with a maximum efficiency.

The actual efficiency of the lamp is a difficult matter for determination, but in this respect it is not greatly different from any other lamp. Until the question of the real mechanical equivalent of light is determined the mechanical efficiency of a lamp must remain an indefinite quantity. At the same time it has long been realized that the efficiency of the arc lamp is much higher than that of the incandescent filament, while for an intermediate degree of brilliancy, such as is often required, neither form of lamp has met the demand for light with a minimum consumption of current.

Experience has shown, however, that in comparison with the standard 16-candle power incandescent lamps, an equivalent degree of illumination is obtained by use of the Nernst lamp with a consumption of about 1½ watts per candle.

THE ENGINEERING INDEX

THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Masonry and Steel Arches on the Chicago, Milwaukee & St. Paul. Describes interesting bridge, and construction work on this line, including a masonry bridge, 360-ft. in length and a 207-ft. 3-hinged hyperbolic arch. 900 w. Ry Age—Aug. 8, 1902. No. 49943.

Culvert.

Design of a Concrete-Steel Arch Culvert. Daniel B. Luten. On the treatment of this material, and discussion of principles of construction. Ill. 2500 w. R R Gaz—Aug. 1, 1902. No. 49762.

Foot-Bridge.

Suspension Foot-Bridge, Easton, Pa. John McNeal, Jr. Brief illustrated description. 700 w. Eng Rec—Aug. 9, 1902. No. 49962.

Girder Supports.

Roller Bearings (Ueber Wälzungslager). Dr. Julius Mandl. An analytical discussion of the action of roller bearings under heavy pressure as in supporting the ends of bridge trusses. 3000 w. Oesterr Wochenschr f d Oeffent Baudienst—July 19, 1902. No. 50146 B.

Melan Arch.

Boulder Faced Melan Arch Bridge.

We supply copies of these articles. See page 163.

National Park, Washington, D. C. W. J. Douglas. Illustrated description of a bridge of reinforced concrete construction. Specifications for the facing are given. 1600 w. Eng News—Aug. 14, 1902. No. 49983.

Metal Arches.

The Computations for Flat Metallic Arches (Calcul des Arcs Métalliques Surbaissés). L. de Boulougne & M. Bedaux. Deriving formulas for arches in which the rise is small compared with the span, including various conditions of loading and forms of construction. 12000 w. 1 plate. Ann des Ponts et Chaussées—1 Trimestre, 1902. No. 50130 E+F.

New York.

Progress on the New East River Bridge at New York City. Report of the Commissioner of Bridges, for the six months ending June 30, 1902. 1400 w. Eng News—Aug. 21,1902. No. 50064.

Plate-Girder.

A Solid-Floor Single-Track Plate-Girder Bridge. Brief description of bridge on the Lake Erie & Western R. R. 800 w. Eng Rec—Aug. 16, 1902. No. 50018.

Pontoon.

Pontoon Foot Bridge Over the Chicago River. Illustrated description of a temporary bridge for the convenience of the people while a new bridge is being built. 500 w. Eng. News—Aug. 21, 1902. No. 50065.

Swing Bridge.

A Sydnev Bridge. Briefly describes the Pyrmont Bridge at Sydney, N. S. W., and its construction. The motive power is electricity. Bv simply pressing a button the bridge, weighing 800-tons, can be opened or closed in 44 seconds. 800 w. Elec Rev, N. Y—Aug. 23, 1902. No. 50054.

Viaducts.

Erection of the Uganda Railway Viaducts. Describes the erection of the superstructure by an overhead steel tower traveler with two 70-ft. booms which overhung the completed structure far enough to assemble a tower and two spans in advance. 1200 w. Eng Rec—Aug. 2, 1902. No. 49859.

CANALS, RIVERS AND HARBORS.

Canal Traction.

Mechanical Traction on the Nivernais Canal (Canal du Nivernais—Touage Mécanique). M. Mazoyer. Illustrating the chain towing barges used on the Nivernais Canal connecting the Seine and the Loire. 3500 w. 1 plate. Ann des Ponts et Chaussées— 1 Trimestre, 1902. No. 50133 E+F.

See Electrical Engineering, Power Applications.

Docks.

Dock Construction in and Around Buffalo. S. M. Kielland. Briefly considers excursion docks, lumber docks, docks for rails, stone and heavy materials, ore docks, and retaining docks. 3300 w. Jour Assn of Engng Soc's—June, 1902. No. 49719 C.

Floating Docks.

The Great Floating Docks, of Bermuda and Algiers, La. Robert C. Fyfe. Illustrations, descriptions and comparison. 1700 w. Sci Am—Aug. 9, 1902. No. 49875.

Floods.

A Study of the Southern River Floods of May and June, 1901. An abstract of the report of E. W. Myers to the U. S. Geol. Survey. 4400 w. Eng News—Aug. 7, 1902. No. 49892.

Locks.

Submarine Concrete Foundations for the Locks at Nussdorf (Betonierung unter Wasser bei der Schleusen-Anlage in Nussdorf). F. Grohmann. A detailed account of the important foundation work of the lock chambers of the Danube Canal at Nussdorf. Serial, Part I. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—July 25, 1902. No. 50144 B.

London.

The Port of London and the Thames. Reviews the report of the Commission appointed by the Board of Trade to inquire into the condition of this port and its navigable disadvantages, and discusses the subject generally. 3000 w. Engr, Lond—Aug. 8, 1902. Serial, 1st part. No. 50030 A.

Manila Harbor.

The U. S. Government Harbor Improvements and Naval Coal Storage Plant at Manila. An illustrated description of extensive work to aggregate some $2,800,000, representing the best modern practice. 3200 w. Eng News—Aug. 7, 1902. No. 49890.

Mississippi.

Growth of the Mississippi Delta. Warren Upham. Information of the growth and changes of the delta and mouths of this river. 3500 w. Am Geol—Aug., 1902. No. 49973 D.

Piers.

The Tyne North Pier Reconstruction. View and description of the work and methods of construction. 1500 w. Engng—Aug. 1, 1902. No. 49921 A.

Rhine.

The Regulation of the Rhine between the Vorarlberg and Switzerland (Die Rheinregulierung zwischen Vorarlberg and Schweiz). With a profile showing the slopes and the various stages of high and

low water. 1500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—July 19, 1902. No. 50147 B.

River Regulation.

River Regulation in Upper Austria. (Die Flussregulierungs- und Wildbachverbauungs-Action in Oberoesterreich). With map showing present and proposed works, and with data as to cost of the works. 1200 w. Oesterr Wochenschr f d Oeffent Baudienst—July 26. 1902. No. 50149 B.

St. Lawrence.

Improving St. Lawrence River Route. Outlines the proposed improvements to facilitate navigation, better lighting, dredging, etc. 1600 w. Marine Rev—Aug. 21, 1902. No. 50210.

Seine.

The Navigable Seine (La Seine Maritime). L. Sekutowicz. An exhaustive discussion of the river Seine as a navigable stream from the sea, with especial reference to the port of Rouen. Four articles. I plate. 10000 w. Génie Civil—July 19, 26, Aug. 2, 9, 1902. No. 50100 each D.

Stream Flow.

The Form of a Course of Water with a Shifting Bed (Forme des Cours d'Eau à Fond Mobile). G. Poisson. An analytical study of the flow of water in streams, taking into account the variations in the form of cross section due to the shifting of the bed. 12000 w. 2 plates. Ann des Ponts et Chaussées—1 Trimestre, 1902. No. 50128 E+F.

CONSTRUCTION.

Cellar Bracing.

Cellar Bracing in the New York Stock Exchange. This building is remarkable for the character and depth of the foundations. Some of the features of special construction used in providing bracing to resist hydraulic pressure below the groundwater line are described in this article. Ill. 3500 w. Eng Rec—Aug. 16, 1902. No. 50019.

Cofferdam.

Repairing a Leaky Cofferdam. Briefly describes method used at Massena, N. Y. 600 w. Eng Rec—Aug. 23, 1902. No. 50224.

Column Bearing.

Computations for a Ball Joint (Beitrag zur Berechnung eines Kugelgelenks). M. Marcus. A mathematical discussion of the stresses in the end of a column provided with a spherical bearing. 800 w. Schweizerische Bauzeitung—Aug. 9, 1902. No. 50123 B.

Dams.

The Assuan Dam and Reservoir on the River Nile. Clarence T. Johnston. Brief illustrated description, with information relating to the operation, cost, etc. 2200 w. Eng News—Aug. 14, 1902. No. 49987.

The New Croton Dam. An illustrated article describing work of interest, made necessary by the change of design, and the methods of construction. 2800 w. Eng Rec—Aug. 16, 1902. No. 50014.

The Solidification of Earth Dams (Le Corroyage des Digues en Terre). M. Galliot. Describing improved forms of rollers driven by steam, by electricity and by petrol, for the solidification of dams constructed of earth. 3500 w. 1 plate. Ann des Ponts et Chaussées—1 Trimestre. 1902. No. 50132 E+F.

Embankments.

A Novel Method of Constructing High Embankments. Illustration with brief description of a temporary suspension bridge used in constructing a high embankment near Freiburg, Switzerland. 350 w. Eng News—Aug. 21, 1902. No. 50063.

Piers.

See Civil Engineering, Harbors.

Simplon Tunnel.

Observations on the Alignment of the Simplon Tunnel (Ueber einige Wahrnehmungen bie den Richtungskontrollen am Simplontunnel.) M. Rosenmund. A discussion of the operative difficulties encountered in the establishment of the line of the Simplon tunnel. 3000 w. Schweizerische Bauzeitung—Aug. 2, 1902. No. 50125 B.

The Work on the Simplon Tunnel (Die Bauarbeiten am Simplon Tunnel). H. Pflug. A general account of the work on the Simplon tunnel with a comparison with the previous tunnels through the Alps. 5000 w. Glasers Annalen—July 15, 1902. No. 50118 D.

Tall Building.

The Flat Iron Building, New York. Illustrations with brief description of this conspicuous New York office building. 800 w. Ir Age—Aug. 21, 1902. No. 50045.

MATERIALS.

Cement.

The Chemical Analysis of Portland Cement; Its Possibilities and Its Limitations. Richard K. Meads. Read before the Am. Soc. of the International Assn. for Testing Materials. 2400 w. Eng Rec—Aug. 9, 1902. No. 49963.

Compression.

The Elastic Deformation of Members Subjected to Horizontal Compression (Déformation Elastique dans les Pièces Comprimées Horizontales). E. Lebert. Discussing analytically the stresses in the members of the proposed transporting

bridge across the Loire at Nantes. 10000 w. Annales des Ponts et Chaussées—1 Trimestre, 1902. No. 50129 E+F.

Mortar.

Tests of Special Properties of Mortar. Brief report of the results of extensive experiments made to determine the permeability and strength of mortars made of the natural and Portland cement mixed with varying proportions of coarse and fine sands. 700 w. Eng Rec—Aug. 16, 1902. No. 50017.

Reinforced Concrete.

Concrete and Melan Arches. L. K. Sherman. From a paper before the Illinois Soc. of Engrs. Concerning the computation of arches. 2000 w. Munic Engng—Aug, 1902. No. 49822 C.

The Permissible Stresses in Reinforced Concrete Construction (Ueber die Zulässige Beanspruchung der Baustoffe in Cement - Eisenconstructionen). J. E. Brik. An examination of the manner in which the elastic limit of the material is reached in the various portions of a structure. 5000 w. Oesterr Wochenschr f d Oeffent Baudienst—July 26, 1902. No. 50148 B.

Concrete-Steel. Condensed from a paper by Prof. Brik in the *Oesterr-Wochenschr f d Oeffent Baudienst.* Gives results of experimental investigations of this material by others, and methods of computation of stresses. 4200 w. Eng Rec—Aug. 23, 1902. No. 50225.

Experiments with Reinforced Concrete (Experiences sur le Ciment Armè). M. Breuillé. Giving data and results of tests showing especially the nature and extent of the adherence of the metal to the concrete. 3500 w. Ann des Ponts et Chaussées—1 Trimestre, 1902. No. 50131 E+F.

Reinforced Concrete Construction. George Hill. An illustrated description of American methods of using this material, discussing its advantages and applications and also its economy. 3300 w. Arch Rec—Sept, 1902. No. 50047 C.

Test of a Concrete Slab Reinforced with Expanded Metal. O. W. Connet. Describes method of testing a six-inch slab, and gives results. Ill. 600 w. Eng Rec—Aug. 2, 1902. No. 49860.

See Civil Engineering, Bridges.

Timber Preserving.

The Present Condition of Timber Preserving in the United States. Reviews the art, giving a list of the plants now running, their situation and capacity and the processes used. 1800 w. R R Gaz—Aug. 8, 1902. No. 49966.

Uralite.

Uralite. A material that is claimed to be made of mineral substances only; to be fire-proof and practically water-proof; to be a non-conductor of heat, cold and electricity, not affected by hot or cold water, by atmospheric influences, nor such gases as will destroy galvanized iron, is described, and some of its uses given. 2300 w. Engr, Lond—Aug. 15, 1902. No. 50088 A.

Uralite. Editorial on this material and the fire-proof tests carried out by the British Fire Prevention Committee. Describes the manufacture of the material. 2800 w. Engng—Aug. 15, 1902. No. 50096 A.

MEASUREMENT.

Boundary Survey.

The Arid District Between the Rio Grande and the Pacific, Traversed by the Engineers of the Mexican Boundary Commission in 1892-94. Prof. Oscar C. S. Carter. A review and discussion of the report of the Mexican Boundary Commission. 7500 w. Pro Engrs' Club of Phila—July, 1902. No. 49722 D.

Surveying.

Fergusson's System of Surveying. John C. Fergusson. Describes and illustrates the use of Fergusson's surveying circle and percentage unit of angular measurement. 2800 w. Engng—July 25, 1902. No. 49796 A.

Weight Computations.

The Weight of Girders. H. G. Tyrrell. Gives diagrams for determining the weight of steel trusses and plate girders, with explanation of their use. 600 w. Engng—July 25, 1902. No. 49794 A.

MUNICIPAL.

Fire Appliances.

"First Aid" Fire-Extinguishing Appliances. Edward George Rivers. Describes the best appliances known for quickly extinguishing fire, and remarks on the importance of their extended use. 900 w. Engng—July 25, 1902. No. 49793 A.

Fire-Escape.

The Schapler Fire-Escape. Illustrations, with brief description of a telescopic fire-ladder built of metal and in use in Frankfort, Germany. 1200 w. Engr, Lond—July 25, 1902. No. 49787 A.

Garbage.

The Garbage Disposal Problem in Boston and Elsewhere. Editorial discussion of sanitary garbage disposal. 2000 w. Eng News—Aug. 7, 1902. No. 49891.

Pavements.

Tar Macadam. George H. Owen. Extracts from a paper presented to the Midland Munic. Officers' Assn. Information concerning this pavement, claiming that its greater first cost is more than offset by its greater durability. 1200 w. Eng Rec—Aug. 9, 1902. No. 49964.

Vitrified Brick Pavements. William Pierson Judson. Describes the characteristics and construction of these pavements and their increasing use in the United States. 2000 w. Munic Jour & Engr—Aug., 1902. No. 49743 C.

Sewage.

The Present Status of the Sewage Problem in England. Prof. Leonard P. Kinnicutt. Discusses septic tanks, contact beds, and intermittent continuous filtration methods in their relation to the bacterial treatment of sewage. Discussion and illustrations. 12800 w. Jour Assn of Engng Socs—June, 1902. No. 49716. C.

Sewage Filter.

The Stoddart Continuous Sewage Filter. Describes a continuous filter which, it is claimed, may be worked at unusual high rates, with no devices for artificial aeration. Gives results of experience. Ill. 2800 w. Eng Rec—Aug. 23, 1902. No. 50223.

Sewers.

Some Details of Sewer Construction. Extracts from a paper by J. C. Meem, read before the Brooklyn Engrs' Club, giving valuable illustrated descriptions of details of sewer construction. 2000 w. Munic Engng—Aug., 1902. No. 49821 C.

WATER SUPPLY.

Aqueducts.

The Loss of Capacity of the Vyrnwy Aqueduct, Liverpool, Egland. Describes the investigations which led to the discovery of a troublesome growth, and discusses means of overcoming the difficulty. 2000 w. Eng Rec—Aug. 2, 1902. No. 49858.

Calcutta.

The Dual Water Supply of Calcutta. Describes the two distinct systems of waterworks made necessary by local conditions. 3000 w. Eng Rec—Aug. 9, 1902. No. 49960.

Electrolysis.

See Street and Electric Railways, Stray Currents.

Filtration.

Modern Filtration. Robert E. Milligan. An explanation of the requirements of modern plants and the processes used. Ill. 1800 w. Munic Engng—Aug., 1902. No. 48820 C.

The Slow Sand Filters of the Water-Works of Hudson, N. Y. H. K. Bishop. An illustrated account of these filter beds and their operation. They were constructed in 1874-5, and 1888 respectively. 1100 w. Eng News—Aug. 14, 1902. No. 49989.

Pipe Coatings.

Coatings for Cast-Iron Pipes. Thomas H. Wiggin. Read before the Boston Soc. of Civ. Engrs. Gives the results of writer's experiments in connection with the Metropolitan water-works. 3500 w. Dom Engng—Aug. 25, 1902. Serial. 1st part. No. 50211 C.

Pressure Regulator.

Note on Some Experiments with a New Form of Pressure Regulator. William Kendrick Hatt. Illustrates and describes apparatus for pipe lines, and records experiments made at Purdue Univ. 1200 w. Jour Fr Inst—Aug., 1902. No. 49818 D.

Pumping Plants.

Turbine Pumping Plants at Water-Works. Abstracts of three papers presented at meeting of the Brit. Assn. of W. Wks. Engrs., describing different turbine-driven plants at water-works. 2500 w. Jour Gas Lgt—Aug. 12, 1902. No. 50051 A.

Purification.

St. Louis Water Purification. Minority report of the commissioners. The plan of Allen Hazen. 3000 w. Fire & Water—Aug. 16, 1902. No. 50041.

Rainfalls.

Rainfalls. Alfred F. Théard. Facts concerning the local rainfall at New Orleans are given. 4200 w. Jour Assn of Engng Soc's—June, 1902. No. 49717 C.

Rates.

The Adjustment of Water Rates. A study of certain features of a report by Chester B. Davis to the San Antonio, Tex., Water-Works Company, which closed a controversy which had lasted eighteen months. 2000 w. Eng Rec—Aug. 9, 1902. No. 49961.

River Pollution.

An Important Decision Concerning River Pollution by Sewage. Condensed from decision of Ohio Supreme Court, in Balliett vs. City of Mansfield. 6400 w. Eng Rec—Aug. 16, 1902. No. 50020.

Water-Fittings.

Standardization of Water-Fittings. R. S. Lloyd. Extracts from a paper and discussion at the annual meeting of the Brit. Assn. of W. Wks. Engrs. Briefly reviews development and present practice, and discusses the advantages of standardization. 4800 w. Jour Gas Lgt—Aug. 5, 1902. No. 49979 A.

Water Rights.

The Relative Rights of Power Plant Owners and Cities to River Water. An opinion of the Ohio Supreme Court. 3300 w. Eng Rec—Aug. 9, 1902. No. 49965.

Wells.

The Water Supply of the Michigan Asylum for the Insane at Kalamazoo. George S. Pierson. A statement of the

conditions, with illustrated description of the new well, which is connected by a siphon with the old well. 2000 w. Eng Rec—Aug. 16, 1902. No. 50015.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable Testing.

See Electrical Engineering, Measurement.

Coherers.

The Inherent Nature of Coherers. Edward P. Thompson. Gives experimental evidence to prove that sparks start a coherer into action. 2000 w. Elec Rev, N Y—Aug. 2, 1902. No. 49831.

Rates.

Telephone Rates from an Engineer's View Point. Franz J. Dommerque. Reviews the present method of charging for telephone service, outlining a scheme for charging, the kinds of rates, and the amount to be charged. 2800 w. Trans Am Inst of Elec Engrs—April, 1902. No. 49809 D.

Inductive Resistance.

Improvement in Electric Transmission by Wires. Charles E. Fritts. An illustrated account of the principles involved in a method of suppressing the inductive resistances which are encountered in telegraph and telephone lines and cables. 3000 w. Elec Wld & Engr—Aug. 2, 1902. No. 49854.

Space Telegraphy.

Electrical Resonance and Its Relation to Syntonic Wireless Telegraphy. A. Frederick Collins. Explains the fundamental principles underlying wireless telegraphy, upon which the art of syntonic methods is based, and discusses the working out of these laws as related to syntonic wireless telegraphy. Ill. 1700 w. Sci Am—Aug. 23, 1902. Serial. 1st part. No. 50059.

Hertzian Waves and Wireless Telegraphy. A. Frederick Collins. Gives a summary of opinions regarding the nature of the waves employed, the writer advocating the "rectilinear propagation of free waves." Also editorial notes. 4800 w. Elec Wld & Engr—Aug. 2, 1902. No. 49855.

The De Forest System of Wireless Telegraphy. An illustrated historical account of this system which is in operation between the Battery and Staten Island, N. Y. 1600 w. Sci Am—Aug. 16, 1902. No. 49996.

The Fessenden Wireless Telegraph Patents. A. Frederick Collins. An illustrated review of the work of Prof. Reginald A. Fessenden in the field of wireless telegraphy. 1800 w. Elec Wld & Engr—Aug. 23, 1902. No. 50221.

The Future of Wireless Telegraphy. P. T. McGrath. Gives a survey of the whole field of possible operations, noting the scientific, mechanical and competitive difficulties, its utilitarian features, and the outlook. 4200 w. N Am Rev—Aug., 1902. No. 49804 D.

The New Marconi Wireless Telegraph Station at Cape Breton. An illustrated description of the four great towers for carrying the vertical wires, to be used for transmission across the ocean. 1000 w. Sci Am—Aug. 9, 1902. No. 49876.

Wireless Telegraphy in Meteorology. Emile Guarini. An illustrated article describing observations, and apparatus used, investigating atmospheric electrical phenomena. 2500 w. Elec Wld & Engr—Aug. 2, 1902. No. 49853.

Wireless Telegraphy. Jno. Gordon Gray. Reviews the early attempts at telegraphing without wires, and the history of modern wireless telegraphy from the visit of Marconi to England in 1896, describing various methods. Discussion. 3200 w. Pro Engrs' Club of Phila.—July, 1902. No. 49723 D.

Telegraphy.

Delay and Output. C. H. Garland. Gives some interesting results from notes by Signor Ettore Rossi bearing upon this question. 800 w. Elect'n, Lond—July 25, 1902. No. 49779 A.

Telephone Exchanges.

Common Battery for Small Exchanges. S. P. Grace. Gives calculations and experiments demonstrating the feasibility and economy of transmitting sufficient battery over the toll lines to small town exchanges, and still be able to talk over the toll lines at the same time. Ill. 4000 w. Telephony—Aug., 1902. No. 49826.

The New Small Branch Exchanges of the Post-Office Telephone Service. An illustrated detailed description of one of the two completed exchanges, typical of the plan the Post-Office proposes to follow in other small branch exchanges in the neighborhood of London. 2500 w. Elect'n, Lond—July 25, 1902. Serial. 1st part. No. 49778 A.

Telephony.

Telephony in Australia. Interesting information from a government report, regarding the status of telephony and the proposals for the reconstruction and development of the systems of the commonwealth. 1800 w. Elec Wld & Engr—Aug. 2, 1902. No. 49852.

The Telephonic Status Quo. Arthur Vaughan Abbott. A discussion of the present situation, briefly reviewing the his-

tory and considering the outlook. 4500 w. Trans Am Inst of Elec Engrs—April, 1902. No. 49808 D.

DISTRIBUTION.

Cables.

The Utilization of Space in Cable Strands (Ueber die Raumausnutzung von Litzen). Dr. Paul Holitscher. A discussion of the twisting of cable strands so as to secure the greatest cross section in a given space. 2500 w. Elektrotech Zeitschr—July 31, 1902. No. 50165 B.

Underground Cable Laying. A. T. Stewart. Illustrates and describes various methods in use in electrical distribution. 3000 w. Elec Engr, Lond—Aug. 1, 1902. No. 49918 A.

Circuit Breakers.

High Tension Circuit-Safeguards. Joseph Martin Roman. An illustrated review of various controlling and safety appliances. 5000 w. Elec Wld & Engr—Aug. 16, 1902. No. 50013.

Earthing.

Notes re Earthing. H. Faraday Proctor. Read at the I. M. E. A. Convention. A consideration of intentional and accidental earths, and the problems arising from them. Aso discussion. 4500 w. Elec Times—July 31, 1902. No. 49903 A.

Sparking.

Sparking in Switches. A. Russell. Résumé of a paper communicated to the *Journal* by the Inst. of Elec Engrs., giving results of experiments made to find a better method for the rating of switches. 1500 w. Elec Times—July 31, 1902. No. 49902 A.

Two and Three Wires.

The Relative Advantages of Two and Three Wire Distribution. John F. C. Snell. Read before the Incor. Munic. Elec. Assn. Compares a three-wire system with 400-volts across the outers, and a two-wire system 200-volts, discussing the relative economies. Discussion. 5800 w. Elec Engr, Lond—July 25, 1902. No. 48776 A.

ELECTRO-CHEMISTRY.

Batteries.

How to Make a Dry Battery. William A. Del Mar. Instructions for making dry cells of the Burnley type. Ill. 500 w. Sci Am Sup—Aug. 2, 1902. No. 49752.

Electro-Refining.

The Financial Basis and Design of Electrolytic Metal Refineries. Arnold Philips. From a forthcoming work entitled "The Electro-plating and Electro-refining of Metals." Information aiming to aid in the designing of an electrolytic refinery upon a sound financial basis. Considers the establishment of an electrolytic copper refinery. 2000 w. Elect'n, Lond—Aug. 1, 1902. Serial. 1st part. No. 49920 A.

Nitrogen.

The Fixation of Atmospheric Nitrogen. Illustrated article regarding the producing artificially nitrates and nitric acid on a commercial scale. Also editorial comment. 2000 w. Elec Wld & Engr—Aug. 2, 1902 No. 49850.

ELECTRO-PHYSICS.

Alternating Currents.

Demagnetizing Effects of Electromagnetically Compensated Alternating Currents. Zeno E. Crook. Gives methods of studying the alternating current effect on hysteresis. Ill. 2500 w. Am Jour of Sci—Aug., 1902. No. 49806 D.

Discharge.

The Mechanical Phenomenon of the Disruptive Discharge (Sur les Phénomenes Mécaniques de la Décharge Disruptive.) J. Semenov. Examining the conditions of the transport of material from one pole to another. 1200 w. Comptes Rendus—July 21, 1902. No. 50173 D.

Electromagnetism.

The Magnetic Effect of Electric Displacement. John B. Whitehead, Jr. Describes a series of experiments undertaken because of the uncertainty of the results of all effort to observe the magnetic effect, and the fact that the method employed had certain advantages over those used heretofore. Ill. 6500 w. Am Jour of Sci—Aug., 1902. No. 49805 D.

Geissler Tubes.

Geissler Tube and Condenser Effects. Alfred G. Dell. Gives causes of the effects observed by the writer in experimental work. 1000 w. Elec Wld & Engr—Aug. 23, 1902. No. 50220.

Induced Currents.

The Dissipation of Energy by Electric Currents Induced in an Iron Cylinder When Rotated in a Magnetic Field. Ernest Wilson. Read before the Royal Society. A comparison is made between the results of experiment and theory. Ill. 2000 w. Elec Engr, Lond—Aug. 15, 1902. Serial. 1st part. No. 50082 A.

Influence Machine.

A Large Influence Machine. H. S. Allen. An illustrated description of a large influence electrical machine, of the Wimshurst type, recently presented to the Royal Infirmary, Glasgow. 1500 w. Elec Rev, Lond—Aug. 15, 1902. No. 50085 A.

Magnetism.

The Real Nature of Electricity and Magnetism. Arthur A. Skeels. Gives results and conclusions from experimental investigations, discussing special cases. 3800 w. Jour Assn of Engng Soc's—June, 1902. No. 49718 C.

We supply copies of these articles. See page 163.

Radiography.

The Gundelach-Dessauer Röntgen Tubes (Die Gundelach-Dessauer'sche Röntgenröhre). Ludwig Henne. Describing an improved form of vacuum tube in which a regulating device is introduced. 1500 w. Elektrotech Zeitschr—July 31, 1902. No. 50166 B.

GENERATING STATIONS.

Alternator Construction.

A New Frame Construction for Alternators (Ueber eine Neue Gehäusekonstruktion von Wechselstrommaschinen). H. Böhmländer. Illustrating a built-up ring of structural wrought iron, in place of the usual cast frame. 1200 w. Electrotech Zeitschr—Julv 24, 1902. No. 50162 B.

Bogota, Columbia.

A Modern South American Light and Power Plant. Frank C. Perkins. Brief illustrated description of the electric plant at Santa Fe de Bogota, which is 8,300 feet above the sea level, and interesting because of the difficulties in its construction and its general arrangements. 2000 w. Elec, N Y—Aug. 20, 1902. No. 50052.

Commutation.

Sparkless Commutation: How to Obtain It. F. W. Davies. Deals with those points in ordinary designing by attention to which it is possible to obtain good collection. 2000 w. Elec. Engr, Lond—Aug. 15, 1902. No. 50084 A.

Düsseldorf Exposition.

Heavy Electrical Machinery at the Düsseldorf Exposition (Die Starkstromtechnik auf der Ausstellung in Düsseldorf 1902). A. Seyfferth. A general description of the powerful generators and electrical machinery at Düsseldorf. Serial. Part I. 4000 w. Elektrotech Zeitschr—Aug. 14, 1902. No. 50169 B.

Dynamo-Driving.

Belt-Drives for Dynamos. W. H. Wakeman. On the location of belts, illustrating defective arrangements and showing wherein improvements could be made. 1900 w. Engr, U S A—Aug. 15, 1902. No. 50003.

Gas Driving.

The Romanshorn Gas Engine Driven Central Power Station. Frank C. Perkins. An illustrated description of a Swiss installation. 1100 w. Elec Rev, N Y—Aug. 9, 1902. No. 49951.

High Pressure.

Modern High Pressure Installations in American Cities (Moderne Hochspannungsanlagen in Amerikanischen Grossstädten). W. Blanck. Describing various generating plants and transforming stations, mainly in the business district of Chicago. Two articles, 7500 w. Elektrotechnische Zeitschr—July 31, Aug. 7, 1902. No. 50163, each B.

Hydro-Electric Plant.

Missouri River Power Company's 5,000-Volt Transmission Plant. A. W. Clapp. An illustrated account of improvements added to the Canon Ferry plant, and of the new sub-station at Butte. 2500 w. Elec Wld & Engr—Aug. 9, 1902. No. 49954.

The Largest Electrical Transmission of Water Power in Massachusetts. Alton D. Adams. An illustrated description of the plant at Red Bridge on the Chicopee River which is utilized by the Ludlow Manufacturing Co., four and one-half miles distant. 1700 w. Elec Wld & Engr—Aug. 16, 1902 No. 50011.

Two Recent Water-Power Plants on the Arve River, France. From *Le Genie Civil.* Describes two plants recently developed to furnish power for an electric railway running from Fayet to Chamonix. 1400 w. Eng Rec—Aug. 16, 1902. No. 50016.

Isolated Plant.

An Interesting Residential Electric Light and Power Plant. Illustrated description of a fine private plant at Fisher's Island, N. Y. 2500 w. Am Elect'n—Aug., 1902. No. 49885.

Ludwigshafen.

The Municipal Electric Plant at Ludwigshafen on Rhine (Städtisches Elektricitätswerk Ludwigshafen a. Rh.). Rudolf Gassner. With plans of the buildings and general description of the entire plant. 2000 w. Elektrotech Zeitschr—July 24, 1902. No. 50159 B.

Newcastle-On-Tyne.

Newcastle and District Electric Lighting Co.'s Power Stations. W. D. Hunter. Illustrates and describes the Forth Banks and Close power stations and their equipment. 8 plates. 4000 w. Inst of Mech Engrs—July 29, 1902. No. 49896 D.

The Electric-Supply Power-Station at Neptune Bank, Newcastle-Upon-Tyne. W. B. Woodhouse. An illustrated description of the first station to supply electric power in bulk in England, and also of its equipment. 2800 w. Inst of Mech Engrs—July 29, 1902. No. 49895 D.

Power Factor.

See Electrical Engineering, Measurement.

Power Plants.

See Mechanical Engineering, Steam Engineering.

Rating.

See Electrical Engineering, Measurement.

Reconstruction.

Reconstructed Central Station and Sub-Stations. Illustrated detailed description of the plant of the New York & Queens

Electric Light & Power Company. 3600 w. Am Elect'n—Aug., 1902. No. 49882.

Winding.

A Simple System for Armature Windings (Eine Sehr Einfache Darstellung Fortlaufender Geschlossener Wickelungen). W. Kübler. Giving a series of numerical tables for use with different kinds of windings. 1200 w. Elektrotech Zeitschr—July 17, 1902. No. 50158 B.

LIGHTING.

Arcs.

The Flaming Arc Light (Ueber Flammenbogenlicht). W. Wedding. With tables of photometric data for various lengths of arcs, and for specially prepared carbons. 4500 w. Elektrotech Zeitschr—Aug. 7, 1902. No. 50168 B.

Electroliers.

Electric Lights for Proposed Isles of Safety in New York City. Illustrates the first and third prize designs of the Municipal Art Society of New York, with critical comment. 400 w. Eng News—Aug. 7, 1902. No. 49888.

Illumination.

Light and Methods of Illumination. Discussion. 7800 w. Trans Am Inst of Elec Engrs—April, 1902. No. 49813 D.

Lamps.

Edison's Tungstate of Calcium Lamp. William J. Hammer. Especially discusses investigations made of the properties of radium. 3400 w. Trans Am Inst of Elec Engrs—April, 1902. No. 49814 D.

Performance of Present 220-Volt Lamps. F. W. C. Bailey. Read at the Nat. Elec. Lgt. Assn. meeting. An account of an interesting test made, the methods and results. Diagrams. 5000 w. Cent. Station—Aug., 1902. No. 49930.

Plymouth, Mass.

Electric Light in the Home of the Pilgrims. Alton D. Adams. A small system which carries an important motor load is described. 1000 w. Elec Rev, N Y—Aug. 16, 1902. No. 49982.

MEASUREMENT.

Alternating Currents.

An Instrument for the Determination of Alternate-Current Curves. Rudolf Goldschmidt. Translated from the *Elektrotechnische Zeitschrift*. Illustrated description of a simple instrument, explaining the principle upon which it is based. 600 w. Elec Engr, Lond—July 25, 1902. No. 49774 A.

Cable Testing.

The Capabilities of the Milammeter and the Galvanometer in General and Submarine Cable Testing. C. W. Schaefer. Describes the adaptability of the direct-reading milammeter to measurements of batteries, resistances, etc., and to the practical solution of many problems. 2200 w. Elect'n, Lond—Aug. 15, 1902. Serial. 1st part. No. 50080 A.

Dynamo Tests.

The Arc Works, Chelmsford. An account of a visit to these works to witness a Hopkinson test of two large dynamos, having an output of 800 kw. Ill. 2000 w. Elec Engr, Lond—Aug. 1, 1902. No. 49917 A.

Meters.

Electricity Supply Meter Tests. J. E. Dawson. Describes methods of testing meters for accuracy of registration. 1000 w. Elec Rev, Lond—July 25, 1902. No. 49777 A.

Motor Testing.

A Precise Brake Method for the Determination of the Efficiency of Motors (Eine Genaue Bremsmethode zur Bestimmung des Wirkungsgrades von Elektromotoren). Paul Jobst. Illustrating a convenient arrangement of electric brake, speed indicators, and volt and ammeters for motor testing. 1800 w. Elektrotech Zeitschr—July 17, 1902. No. 50157 B.

Notes on the Testing of Tramway Motors, and an Investigation into Their Characteristic Properties. Michael B. Field. Read before the Glasgow Local Sec. of the Inst. of Elec. Engrs. Shows how such motors may be tested quickly and all their characteristic properties ascertained. 3400 w. Elec Engr, Lond—Aug. 15, 1902. Serial. 1st part. No. 50081 A.

Power Factor.

Direct-Measurement of Wattless Power Budd Frankenfield. Explains a method devised by the writer for reading wattless power directly in a balanced three-phase circuit. Also editorial. 2500 w. Elec. Wld & Engr—Aug. 16, 1902. No. 50012.

Rating.

The Rating of Motors and Generators. Dr. M. G. Rasch. Read before the International Tramways Union, at Islington. A discussion of the basis that should be adopted in estimating the power. 4500 w. Elect'n, Lond—Aug. 8, 1902. No. 50028 A.

Resistance.

On the electrical Resistance of Glass, Quartz, Mica, Ebonite and Gutta-percha. Ogden N. Rood. Gives measurements of the external and internal resistances of certain insulating substances, describing the mode of experimenting. 1500 w. Am Jour of Sci—Aug., 1902. No. 49807 D.

Zero Method.

Zero Method for Magnetic Measurement (Nullmethode für Magnetische Messungen). A. Roth. Referring to the method of Goldschmidt, and describing a simple method of approximate accuracy.

We supply copies of these articles. See page 163.

1800 w. Elektrotech Zeitschr—July 24, 1902. No. 50161 B.

POWER APPLICATIONS.

Canal Traction.

Results with Electric Canal Towage in Belgium. Illustrates and describes an installation on a canal between Brussels and Charleroi. 1000 w. Elec Wld & Engr—Aug. 2, 1902. No. 49851.

Car Hoist.

The Hoisting of Cars by an Electric Winch (Hochnehmen Vierachsiger Abtheilwagen durch Elecktrisch Angetriebene Hebeböcke). F. Bergemann. A description of the inclined plane and electrically operated winding machinery used at Eberswalde, Prussia. 2500 w. Glasers Annalen—July 15, 1902. No. 50119 D.

Colliery Plant.

Electric Pumping and Coal-Cutting Plant at the South Durham Colliery, near Bishop Auckland. Describes this plant recently visited by the N. of Eng. Inst. of Min. & Mech. Engrs., reporting addresses on the occasion. 2800 w. Col Guard—July 25, 1902. No. 49781 A.

Systems of Electric Power for Soft Coal Mines. John Price Jackson and William P. Cochran. Considers questions of importance in the relation of the system to be used for power operation, including haulage. Gives a description of the plant at Ehrenfeld, Pa. 2500 w. Eng & Min Jour—Aug. 16, 1902. No. 50010.

Electric Motors.

Some Suggestions with Regard to Electric Motor Installations. Alfred H. Mayes. Considers some of the sources of difficulty offering suggestions from practical experience in regard to the selection of the motor and accessories. 2300 w. Elec Rev, Lond—Aug. 1, 1902. No. 49919 A.

Elevators.

Power Consumption of Elevators Operated by Alternating and Direct-Current Motors. George F. Sever. A report of investigations made to determine the power consumption in the two different lines. Twenty tests were made by senior students in the Elec. Engng. Dept. of Columbia Univ. and the results are tabulated. 1400 w. Trans Am Inst of Elec Engrs—April, 1902. No. 49810 D.

The Electric Elevators at the Paris Post Office (Les Montes-Charges Electriques de l'Hotel des Postes de Paris). V. Belugon. Illustrated description of the electric lifts used for handling the mail at Paris. 1500 w. 1 plate. Genie Civil—July 26, 1902. No. 50101 D.

The Power Equipment of the New Iron Elevator of the Iron Elevator and Transfer Company, Buffalo, N. Y. An illustrated description of an elevator and its equipment, in which the grain is handled by means of endless rubber belt conveyors and elevating legs which are driven by induction motors. 1100 w. Elec Rev, N Y—Aug. 9, 1902. No. 49952.

Haulage.

Electrical Transport of Ores. An illustrated description of the application of electricity for underground haulage. 1600 w. Aust Min Stand—June 26, 1902. Serial. 1st part. No. 49913 B.

Induction Motors.

A Novel Combination of Polyphase Motors for Traction Purposes. Ernst Danielson. Describes an arrangement which makes it possible to obtain economically four different speeds by means of only two motors. Ill. 4000 w. Trans Am Inst of Elec Engrs—April, 1902. No. 49812 D.

Polyphase Induction Motors Operating on Single Phase Circuits. A. S. M'Allister. Describes methods of operating, illustrating the mode of connecting the windings. 600 w. Am Elect'n—Aug., 1902. No. 49884.

The Influence of Closed Slots in Induction Motors (Ueber den Einfluss Geschlossener Nuthen im Inducirenden Theile von Drehstrommotoren). W. Mollier. With diagrams showing the modifications produced when the slots in the inductor are closed with iron. 2000 w. Electrotech Zeitschr—July 31, 1902. No. 50164 B.

Mill Driving.

Lighting and Driving Textile Mills by Electricity. Marshall Osborne. Read before the Dublin Sec. of the Inst. of Elec. Engrs. A review of what has been done in this field, and the advantages gained. 3200 w. Elec Engr, Lond—Aug. 15, 1902. No. 50083 A.

Mining Plant.

Electrical Equipment of the C. & C. Shaft of the Consolidated California & Virginia Mining Company. Leon M. Hall. Illustrated detailed description of this installation, which is considered one of the most complete mining installations in the world, and its operation has been entirely satisfactory. 1600 w. Eng News—Aug. 21, 1902. No. 50067.

Motor Testing.

See Electrical Engineering, Measurement.

Pumping.

Electric Pumping for Irrigation. Aug. I. Bowie, Jr. A discussion of the problems where irrigation is needed, especially where pumps not for deep wells, that are placed where all parts are readily accessible, are used. Also editorial notes. 6300 w. Elec Wld & Engr—Aug. 9, 1902. No. 49955.

We supply copies of these articles. See page 163.

Rating.

See Electrical Engineering, Measurement.

TRANSMISSION.

Lighting Arresters.

Horn Lightning-Arresters with Iron Framing. Eugen Klein. Translated from *Elektrotechnische Zeitschrift*. Illustrates and describes these safety devices, and method of testing. 800 w. Sci Am Sup—Aug. 23, 1902. No. 50062.

Power Plant.

Calculation of a 50,000-Horse-Power, 80,000 Volt, 200-Mile Transmission Line. C. W. Hutton and R. Crowell. Read before the Pacific Coast Elec. Trans. Assn. Considers the proper construction and working qualities of long transmission lines from an electrical standpoint. 2200 w. Jour of Elec—July, 1902. No. 50044.

Switzerland.

The Transmission of Power between St. Maurice and Lausanne (Transport d'Energie de Saint-Maurice à Lausanne). A. Dumas. Describing the transmission of 5,000 horse power over a distance of 56 kilometres, by a continuous current under a pressure of 23,000 volts. 4000 w. 1 plate. Génie Civil—Aug. 2, 1902. No. 50102 D.

Transmission of Energy from St. Maurice to Lausanne, Switzerland. Enrico Bignami. Illustrates and describes an interesting plant transmitting power about 40 miles. A continuous, constant current system was adopted. Editorial comment. 2000 w. Elec Rev, N Y—Aug. 2, 1902. No. 49830.

MISCELLANY.

Electrical Science.

The Old and the New Electrical Theory. Alex. P. Trotter. The object of the paper is to bring together the valuable contributions to electrical science which form a part of what is termed the "new theory." 3000 w. Elec Rev, Lond—Aug. 8, 1902. Serial. 1st part. No. 50027 A.

Practice.

Some Notes on Electrical Engineering Practice in Europe and America. John Denham. Read before the Cape Town Sec. of the Inst. of Elec. Engrs. On Central Station work and the transmission and utilization of electric power as observed by the writer on a recent trip through Europe and America. 6800 w. Elec Engr, Lond—Aug. 8, 1902. No. 50025 A.

GAS WORKS ENGINEERING

Condensation.

Some Experiences With Condensing Plant. William Currie. Read at meeting of the N. Brit. Assn. of Gas Mgrs. Discusses the best methods, describing the plant in use by the writer and its working. 3500 w. Gas Wld—Aug. 2, 1902. No. 49916 A.

Electrolysis.

The Electrolysis of Gas Mains. James Swinburne. Lecture before the Incor. Gas Inst. Aims to give a broad discussion of the subject, furnishing general information. 3000 w. Elect'n, Lond—Aug. 8, 1902. Serial. 1st part. No. 50029 A.

Fuel.

Fuel Conditions in California. J. L. Howard. Read at meeting of the Pacific Coast Gas Assn. Reviews the past history of the fuel trade in this state and discusses the present conditions. 4000 w. Am Gas Lgt Jour—Aug. 25, 1902. No. 50215.

Gallery Illumination.

Lighting of Birmingham Art Gallery. Report by Professor Percy Frankland on experiments made to ascertain whether artificial illumination by electric arc lamps, or by the incandescent gas installation was preferable from the point of view of possible damage to the pictures. 2300 w. Gas Wld—July 26, 1902. No. 49770 A.

Gas Recorder.

See Mining and Metallurgy, Iron.

Incandescent Lighting.

Cause of the Rapid Dimunition in Light from Welsbach Burners. Abstract of a paper by Herr G. Wobbe, read at meeting of the Austro-Hungarian Gas Assn. Discusses how to obtain the greatest possible lighting effect. 700 w. Jour Gas Lgt—Aug. 12, 1902. No. 50050 A.

History of the Invention of Incandescent Gas-Lighting. Auer von Welsbach. An account of this valuable discovery, translated from the *Jour für Gasbeleucht und Wasservers.* 2500 w. Sci Am Sup—Aug. 2, 1902. No. 49753.

The Limit of Temperature Usefulness in the Mantle Light. Dr. W. H. Birchmore. Deductions from experimental researches concerning high temperature flames and combustion at high temperatures. 2000 w. Am Gas Lgt Jour—Aug. 18, 1902. No. 50008.

Liquid Deposits.

On the Liquids Deposited in the Mains and Services of a Gas Supply System. Norton H. Humphreys. Suggests the measuring of this liquid and explains the manner of doing it, and the value of the information obtained. 1200 w. Jour Gas Lgt—Aug. 5, 1902. No. 49977 A.

We supply copies of these articles. See page 163.

Power Gas.

The Generation of Power Gas in Producers and Blast Furnaces (Recherches sur la Production des Gaz des Gazogènes et des Haut Fourneaux). A. Lencauchez. An exhaustive examination of the production, purification and power applications of lean gas. 30,000 w. Mem Soc Ing Civ de France—June, 1902. No. 50-126 G.

Rates.

Gas Rates in the United States. Alton D. Adams. Information concerning production, prices, etc. 2500 w. Munic Jour & Engr—Aug., 1902. No. 49744 C.

Retorts.

Modern Retort House Practice. W. B. M'Lusky. Read at meeting of the N. Brit. Assn. of Gas Mgrs. On the importance of good design and good workmanship in constructing the retort house, and favoring the doing of the heavy work by mechanical means. Ill. and discussion. 4500 w. Gas Wld—July 26, 1902. No. 49769 A.

Water Gas.

On Some Points About the Properties and Testing of Carburetted Water Gas. Prof. C. R. C. Tichborne. Before the Irish Assn. of Gas Mgrs. Discusses the illuminating power, impurities, control of carbon monoxide, etc. 4000 w. Gas Wld —Aug. 16, 1902. No. 50077 A.

More About Methane-Hydrogen Water Gas. C. B. Tully. Read before the Irish Assn. of Gas Mgrs. Describes important features in the modified plant at Sligo, the method of working, and cost. Ill. 1800 w. Gas Wld—Aug. 16, 1902. No. 50078 A.

INDUSTRIAL ECONOMY

Accounting.

Growing Necessity for Reserve Fund. A discussion of this subject in its bearing on electric railway business. 2000 w. St Ry Jour—Aug. 2, 1902. No. 49867 D.

The Utility of Reserve Accounts. A. O. Kittredge. On the wisdom of maintaining large emergency reserves in railroad business, explaining the reserve principle. 2100 w. St Ry Jour—Aug. 2, 1902. No. 49868 D.

Arbitration.

Arbitration or Litigation. Editorial, discussing the working of the English Arbitration Act of 1889, considering some recent cases. 3500 w. Engng—Aug. 1, 1902. No. 49925 A.

Commerce.

American Railroads and Our Commercial Development. Extracts from an address by George H. Daniels, before the Chautauqua Assembly, showing the achievements of American railways. 2400 w. Ry & Engng Rev—Aug. 16, 1902. No. 50006.

Cost Accounting.

The Electrical Tabulating Machine Applied to Cost Accounting. An illustrated article explaining the method of utilizing this machine in manufacturing establishments. 2000 w. Am Mach—July 31, 1902. No. 49728.

Cuba.

The Industrial Development of Cuba. Information concerning the mining and metal working industries. 1500 w. Ir Age—Aug. 14, 1902. No. 49957.

Education.

A Proposed Reform in Technical Training. Edward B. Raymond. The views of the writer are briefly given, advocating a strictly technical course in the training of electrical engineers. 1800 w. Trans Am Inst of Elec Engrs—May, 1902. No. 50237 D.

Electrical Engineering Courses at College and the Education of the Electrical Engineer. William Esty. Discussing electrical engineering education. 4000 w. Trans Am Inst of Elec Engrs—May, 1902. No. 50236 D.

Engineering Education. Charles H. Hines. Words of encouragement to the many who are striving to achieve success without being able to avail themselves of college or technical education, especially in the electrical field. 1500 w. Elec Wld & Engr—Aug. 23, 1902. No. 50222.

The Technical Education and Practical Training of Mechanics and Engineers. Thomas Reid. Lecture before the Dundee Inst. of Engrs. A criticism of the present system in England and outlining two courses of technical training recommended by the author. 6300 w. Mech Engr—Aug. 9, 1902. No. 50023 A.

Exposition.

The German Industrial Exposition at Düsseldorf. Frank C. Perkins. Illustrated description of this exhibition and some of its important engineering exhibits. 3000 w. Sci Am Sup—Aug. 2, 1902. No. 49-750.

German Syndicates.

The German Syndicates and Their Influence on the Recent Panic. Gives facts from various industries, and shows that Germany has a combination of syndicates for the protection of business interests. 2800 w. Ir & Coal Trds Rev—July 25, 1902. No. 49800 A.

We supply copies of these articles. See page 163.

Intensified Production.

Intensified Production and Industrial Investment. William D. Ennis. A discussion of the commercial factors affecting the cost of manufacturing, showing the extent to which the general policy of intensification should sometimes be modified. 3000 w. Engineering Magazine—September, 1902. No. 50186 B.

Machinery.

Machinery and Labor. Henry White. Address before the Am. Soc. of Pol. & Soc. Sci. Discusses the opposition of workmen to labor-saving methods, and shows the material advantages of machinery. 3200 w. Gunton's Mag—Aug., 1902. No. 49802.

Markets.

Future Markets for American Iron and Steel. Axel Sahlin. From the "Report on American Industrial Condition and Competition" by the British Iron Trade Association. 2200 w. Ir Age—Aug. 21, 1902. No. 50046.

Municipal Ownership.

Failure of Municipal Ownership in England. Hon. Robert P. Porter. Gives a brief history of the movement in England in opposition to municipal trading, as it is termed. 7500 w. St Ry Jour—Aug. 2, 1902. Serial. 1st part. No. 49866 D.

Steel Situation.

The Steel Situation in the United States. Editorial discussion of the present condition of the steel industry as shown by recent reports, and the need of a protective tariff. 1700 w. Engng—July 25, 1902. No. 49791 A.

Strikes.

The Resumption of Anthracite Mining. R. W. Raymond. A discussion of the difficulties to be met. A reply to opinions published in the *N. Y. Evening Post*, and the N. Y. *Times*. 2400 w. Eng & Min Jour—Aug. 9, 1902. No. 49947.

The South Wales Miners and the "Stop-day" Decision. Gives criticisms upon this important case by a number of leading daily journals. 4200 w. Ir & Coal Trds Rev—Aug. 15, 1902. No. 50098 A.

The Stop-Day Case. Reviews an important case between capital and labor and the decision rendered by a British court. 3000 w. Engng—Aug. 15, 1902. No. 50095 A.

Wages.

History of the Sliding Scale. From the *South Wales Daily News*. 1500 w. Ir & Coal Trds Rev—Aug. 8, 1902. No. 50038 A.

Water-Power Rights.

French Legislation on the Utilization of Water for Power. Abstract of a paper from *Le Genie Civil*, written by Charles Pinat discussing this subject. 1300 w. Eng News—Aug. 7, 1902. No. 49889.

MARINE AND NAVAL ENGINEERING

Battleships.

Battleship Circular. Description of a vessel for the U. S. Navy, for which bids are invited. 2000 w. Marine Rev—July 31, 1902. No. 49828.

German First-Class Battleship Zaehringen. Describes one of a group of five sister battleships of the Wittelsbach class. Ill. 1300 w. Engr. Lond—July 25, 1902. No. 49788 A.

The Battleships "Connecticut" and "Louisiana." Illustrated detailed description of these two ships which will, when finished, be the finest of their class. 2500 w. Sci Am—Aug. 23, 1902. No. 50061.

Bell Buoy.

Bell Buoy That Rings Under All Conditions. Illustrated description of an improved type in use in Baltimore harbor. 1200 w. Marine Rev—Aug. 14, 1902. No. 49998.

Belleisle Experiments.

The Recent Belleisle Experiment. A description of experiments made (1) to ascertain the effect of lyddite on a conning tower; (2) to ascertain the effect of the same shell on torpedo nets. Ill. 3300 w. Engr, Lond—Aug. 8, 1902. No. 50033 A.

Boilers.

See Mechanical Engineering, Steam Engineering.

Coal Depot.

The Sangley Point Coaling Plant. Illustrated description of a government plant in the Philippine Islands, which includes a dredged approach, a large iron wharf, coal sheds, handling and weighing apparatus, power plant and fire service. 3000 w. Eng Rec—Aug. 9, 1902. No. 49959.

Destroyers.

Contract Trials of Torpedo Boat Destroyers Paul Jones, Perry and Preble. Leo Morgan. Illustrations, with description of the boats and their equipment, and report of trials. 8000 w. Jour Am Soc of Nav Engrs—Aug., 1902. No. 50205 H.

Docking.

Docking Facilities on the Pacific Coast. William H. Crawford, Jr. Illustrations

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with descriptions of the new and old docks at Hunter's Point, near San Francisco, and at Mare Island Navy Yard. 1100 w. Marine Engng—Aug., 1902. No. 49739 C.

Engines.

See Mechanical Engineering, Steam Engineering.

Ferryboat.

Ferryboat Edgewater. Illustrated description of a boat recently put in service between 130th Street, N. Y., and Edgewater, N. J. 1600 w. Marine Engng—Aug., 1902. No. 49737 C.

Lighthouse Tower.

Steel Casing for Brick Lighthouse Tower. Illustrates and describes a method of repair and protection of a tower on Cana Island, Wisconsin. 700 w. Eng News—July 31, 1902. No. 49756.

Lightship.

An Automatic Lightship. Waldon Fawcett. An illustrated description of a lightship stationed at Otter Rock, off the west coast of Scotland. Its ingenious mechanical devices render its service automatic. 800 w. Sci Am—Aug. 2, 1902. No. 49749.

Liner.

New Anchor Liner Columbia. Diagram with brief description of a vessel, which has completed her maiden voyage. 1500 w. Marine Rev—July 31, 1902. No. 49829.

The New German High-Speed Liner "Kaiser Wilhelm II." Begins an illustrated detailed description of this new North German Lloyd high-speed Atlantic liner, which is not only the largest ship yet built, but is to be the fastest. Also considers the type, as a passenger carrier particularly. 3800 w. Engng—Aug. 15, 1902. Serial. 1st part. No. 50089 A.

Liquid Fuel.

Liquid Fuel for Steamships. Edwin L. Orde. Considers the characteristics and calorific value of the various forms available, the general conditions governing its combustion, the type of apparatus for utilizing it, and the results which have been obtained. 5 plates. 4000 w. Inst of Mech Engrs—July 29, 1902. No. 49899 D.

Material Handling.

Handling Steel in Shipyards. Waldon Fawcett. Illustrates and describes the great cantilever cranes, and the methods of handling the heavy material in various ship yards. 2000 w. Am Mfr—Aug. 7, 1902. No. 49931.

Naval Engineers.

Naval Engineers. D. B. Morison, with Editorial. An important letter dealing with the question of engineering *personnel*, with editorial discussion. 5000 w. Engng—July 25, 1902. No. 49797 A.

The Doom of the British Naval Engineer. Charles M. Johnson. A discussion of the persistent official injustice to the engineers of the Royal navy, showing the disastrous results which must follow. 4000 w. Engineering Magazine—September, 1902. No. 50181 B.

The Naval Engineer of the Future. W. M. McFarland. A review of conditions in the United States navy, showing the necessity for all officers to be trained engineers. 3000 w. Engineering Magazine—September, 1902. No. 50180 B.

Powering.

Powering Ships. Horace Holden Thayer, Jr. Discusses two of the statements made by Durand in his work on "Resistance and Propulsion of Ships." 1100 w. Marine Engng—Aug., 1902. No. 49736 C.

Propeller Shafts.

See Mechanical Engineering, Measurements.

Reconstruction.

The Reconstructed Saale. Illustrated description of the extensive changes made in overhauling this vessel which was badly damaged by the Hoboken pier fire. 1000 w. Marine Engng—Aug., 1902. No. 49735 C.

Shipyard.

Messrs. Swan and Hunter's Shipyard. Illustrates and describes this interesting plant at Wallsend-on-Tyne, and the work done there. 3000 w. Engng—Aug. 8, 1902. No. 50035 A.

Special Tools.

Some Special Tools at the Fore River Shipyard. An illustrated description of the equipment of these works, located at Quincy, Mass. Electricity and compressed air are used throughout the plant. 2500 w. Ir Age—Aug. 7, 1902. No. 49873.

Speed Trials.

Notable Trials of Speed Between Early American Steamboats. J. H. Morrison. An interesting account of races previous to the year 1852, on the Hudson River, on Long Island Sound, and other waters. Ill. 4500 w. Naut Gaz—July 31, 1902. No. 49748.

Steamboat History.

Contributions to the History of the Invention of the Steamboat (Zur Geschichte der Erfindung des Dampfschiffs). D. H. Claus. With especial reference to the early work of Papin about 1700, also of Symington and Fulton. 5000 w. Glasers Annalen—Aug. 1, 1902. No. 50120 D.

Steamers.

A Review by Decades of American Deep Water Steamers in the Atlantic Coastwise Service. Ray Morris. An illustrated article showing the tendencies of traffic and of design. 6500 w. R R Gaz—Aug. 15, 1902. No. 59993.

We supply copies of these articles. See page 163.

The Stern-Wheel Steamer Alianza. Drawings and description of a steel steamer built for service in Venezuela. 700 w. Marine Engng—Aug., 1902. No. 49738 C.

Torpedo Boats.

Contract Trial of Torpedo Boat No. 28, the De Long. Lieut. Gustav Kaemmerling. Describes the vessel and its equipment and reports trials. 5000 w. Jour Am Soc of Nav Engrs—Aug., 1902. No. 50206 H.

Submarine Torpedo Boats. G. W. Baird. Describes several designs and gives interesting information relating to them. 2500 w. Jour Am Soc of Nav Engrs—Aug., 1902. No. 50207 H.

The Contract-Speed Trial of the U. S. Torpedo Boat Wilkes. Lieut. Albert Moritz. Describes the boat and its equipment and reports the trial. 3000 w. Jour Am Soc of Nav Engrs—Aug., 1902. No. 50208 H.

Tugboat.

New Boston Tugboat. Illustrates and describes the "John G. Chandler," fitted with machinery of the most modern design and construction. 500 w. Marine Engng—Aug., 1902. No. 49741 C.

Twin Screws.

State Protection for Ocean Travellers. George W. Melville. Urging that all seagoing steamers shall be fitted with twin-screw engines and double bottoms, and with life-saving devices, and obliged to carry enough efficient men and officers to safely operate the vessel. Other suggestions are also given, and their economic advantages shown. 3800 w. N Am Rev—Aug., 1902. No. 49803 D.

U. S. Navy.

Review of the Sanitary Condition of the Navy. John C. Wise. A review showing the great changes and advances made during the last twenty years. 4000 w. San—Aug., 1902. No. 49900 D.

Yachts.

A Steam Yacht for Lake Service. Description and drawings of the 75-foot steel steam yacht "Louise," to be used on Lake Geneva, N. Y. 2000 w. Marine Engng—Aug., 1902. No. 49740 C.

Interior Decorations of the Helenita. Illustrated descriptions of the very fine interior of this yacht built for Frank J. Gould. 1000 w. Marine Engng—Aug., 1902. No. 49742 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Alcohol.

Carbureted Alcohol vs. Pure Gasoline in Automobiles. Marius C. Krarup. A comparison between results obtained with carbureted alcohol in France, and with gasoline in the United States. 2000 w. Ir Age—Aug. 28, 1902. No. 50232.

Axles.

Axles and Springs. F. Gaillardet, in *La France Automobile*. Describes the method of manufacturing hollow axles, and discusses spring suspension in its relation to motor vehicles. 2000 w. Horseless Age—Aug. 13, 1902. No. 49976.

Body Construction.

Features of Body Construction in Recent Foreign Machines. Hugh D. Meier. Notes on recent improvements tending to added comfort. Ill. 1200 w. Horseless Age—July 30, 1902. No. 49727.

Combination System.

The Fischer Motor Vehicle Combination System. Illustrates and describes a system claiming the advantages of the electric and gasoline combined, while the disadvantages of each are practically eliminated. 900 w. Ir Age—Aug. 28, 1902. No. 50230.

Daimler.

1902 Type Daimler Cars. Illustrated description of vehicles embodying the latest and best practice. 3000 w. Auto Jour—July 26, 1902. Serial. 1st part. No. 49765 A.

Endurance Run.

Chicago Endurance Contest.—On a Rambler, No. 16. Thomas I. Stacey. An illustrated account of the run of this machine. 2500 w. Horseless Age—Aug. 13, 1902. No. 49975.

The Chicago 100 Mile Endurance Contest. An illustrated report of the contest which took place Aug. 2, 1902. 2500 w. Horseless Age—Aug. 6, 1902. No. 49872.

Gears.

The Packard Transmission. An illustrated description of this shifting gear transmission. 1600 w. Horseless Age—Aug. 20, 1902. No. 50053.

The Panhard Gear. Brief illustrated description of the Panhard gear. 1400 w. Autocar—Aug. 2, 1902. No. 49910 A.

Ignition.

Ignition Batteries. Albert L. Clough. Describes the dry batteries, discussing their troubles, methods of testing, etc. 1600 w. Horseless Age—July 23, 1902. No. 49771.

Lubrication.

Wrist Pin Lubrication of Vertical Engines—A Positive System. Hugh D. Meier. Describes ways of lubricating

wrist pins, illustrating one device. 1400 w. Horseless Age—July 23, 1902. No. 49772.

Lurries.

Some Recent German Lurries. Illustrates and describes some modern heavy vehicles which present peculiarities of interest. 2000 w. Auto Jour—Aug. 9, 1902. No. 50022 A.

Steam Motor Lorry. Illustrated detailed description of a lorry built from designs of Dr. A. W. Brightmore, and of its operation. 2000 w. Engr, Lond—Aug. 8, 1902. No. 50032 A.

Modern Uses.

Varied Modern Uses of the Automobile. Information, with illustrations of the use of these machines for labor purposes. 1200 w. Sci Am—Aug. 9, 1902. No. 49877.

Paris-Vienna.

The Paris-Vienna Motor Car Races. C. R. D'Esterre. A fully illustrated account of the races, the most important ordeal yet undertaken by motor vehicles. 3000 w. Engineering Magazine—September, 1902. No. 50183 B.

Petrol Car.

The Chatel-Jeannin Petrol Car. An illustrated description of its construction and action. 3300 w. Auto Jour—Aug. 16, 1902. No. 50076 A.

Races.

The Ardennes Circuit. An illustrated account of the circular race organized by the Automobile Club of Belgium. 3000 w. Autocar—Aug. 9, 1902. No. 50021 A.

Serpollet.

The Latest Steam Vehicles of the Gardner-Serpollet Works, Paris (Die Neuesten Dampfwagen von Gardner & Serpollet in Paris). Max Unger. With details of the flash boiler, pumps, valve gear, etc. 3000 w. Glasers Annalen—July 15, 1902. No. 50117 D.

Special Roadway.

Why Not a Motor Car Way Through England? B. H. Thwaite. Suggests the construction, and describes the character of a special roadway for motor vehicles. 1500 w., Nineteenth Cent—Aug., 1902. No. 49972 D.

Tires.

Motor Car Tires. Discusses practical points in the manufacture of rubber tires and their repairs. 2400 w. Engr, Lond—July 25, 1902. No. 49789 A.

Trials.

The Welbeck Speed Trials. An illustrated article giving an account of the gathering, the vehicles, results of contests, etc. 6300 w. Auto Jour—Aug. 16, 1902. No. 50075 A.

The Welbeck Trials. An illustrated account of these trials, with results of the various contests. 3700 w. Motor Car Jour—Aug. 16, 1902. No. 50074 A.

HYDRAULICS.

Elevators.

The Selection and Installation of Hydraulic Elevators. Henry D. James. Gives information relating to the proper design, construction and operation of hydraulic elevators. Ill. 3800 w. Eng News—July 31, 1902. No. 49755.

Hydro-Electric Plants.

See Electrical Engineering, Generating Stations.

Ottawa.

Water Power Development in the Vicinity of Ottawa, Ont. Shows the remarkable wealth of water power, and the applications made of it. Ill. 1400 w. Can Engr—Aug., 1902. No. 49825.

Plumbing.

Plumbing in the Carnegie Residence, New York. Illustrates and describes the arrangement of the piping, valves, etc, for the pump and filter supplies, the cold-water distribution and the hot-water heating supply and return. 3000 w. Eng Rec—Aug. 2, 1902. No. 49862.

Pump.

Mine-Draining Pump. Illustrations with description of a large pump exhibited in the mining section of the Düsseldorf exhibition. It is capable of lifting 5500 gallons per minute against a head of 1640 feet. 700 w. Engng—July 25, 1902. No. 49790 A.

See Electrical Engineering, Power Applications.

See Mining and Metallurgy, Mining.

Sault Ste. Marie.

New Water Power Plant at Sault Ste. Marie, Mich. An illustrated description of the plant on the American side which is expected to be in operation this autumn. 2000 w. Engr, U S A—Aug. 15, 1902. No. 50001.

Water Power.

Some Water Powers of New York State. An illustrated article showing what has been accomplished in developing some of the small streams and what may yet be done. 2800 w. Stone—May, 1902. No. 49985 C.

See Industrial Economy.

MACHINE WORKS AND FOUNDRIES.

Agricultural Machinery.

The Manufacture of Agricultural Machinery. Joseph V. Woodworth. Illustrated description of the work as carried on by the Walter A. Wood Mowing and Reaping Machine Co. of Hoosic Falls, N.

Y. 4500 w. Mach, N Y—Aug., 1902. No. 49745.

Boring Machine.

Boring and Milling Machine for Connecting Rods (Bohr- und Fräsmaschine für Lenkstangen). H. Fischer. Illustrating and describing a special tool by which both ends of a rod are bored and finished at the same time. 1800 w. Zeitschr d Ver Deutscher Ing—July 19, 1902. No. 50110 D.

Brass Founding.

The Use of Plaster of Paris as a Brass Founders' Flux. Edwin S. Sperry, in *Aluminum World*. Concerning the theory and uses of fluxes in general, with detailed description of the flux named. 1300 w. Foundry—Aug., 1902. No. 49815.

Castings.

Dressing Castings. Percy Longmuir. Remarks and suggestions on the trimming of castings. 1600 w. Foundry—Aug., 1902. No. 49816.

Equilibrium of Iron-Carbon Systems. G. Charpy and L. Grenet. An illustrated account of experimental investigations, noting in particular, the results on five castings containing practically the same amount of carbon, and in which the other elements exist in small quantities, except silicon, which is in variable proportions. 1600 w. Jour Fr Inst—Aug., 1902. No. 49817 D.

Molding Bosses on Castings. John M. Richardson. Illustrated description of different methods employed. 800 w. Am Mach—Aug. 7, 1902. No. 49944.

Cost Accounting.

See Industrial Economy.

Dies.

An Automatic Combination Piercing, Bending and Twisting Die for Box Corner Fasteners. Joseph V. Woodworth. Illustrates and describes the die used, which produces these fasteners at so small a cost that they are used instead of nails or screws. 800 w. Am Mach—Aug. 7, 1902. No. 49946.

A Punch and Die for End Finishing, Cutting Off and Bending Sheet Metal from the Strip Without Waste. Also Two Dies for Metal Corner Fasteners. Joseph V. Woodworth. Illustrated description of dies and their operation. 1100 w. Am Mach—Aug. 21, 1902. No. 50057.

Drawings.

Standard Drawings. Warren E. Willis. Gives suggestions for drafting-room standards. 1600 w. Mach, N Y—Aug., 1902. No. 49746.

Flasks.

Combination Iron Flasks. R. H. Palmer. Discusses how to make flasks so that they can be easily altered to take in patterns of different styles. Ill. 1300 w. Am Mach—Aug. 7, 1902. No. 49945.

Foundry Costs.

The Recording and Interpreting of Foundry Costs. Percy Longmuir. A discussion of practical methods from the point of view of the manager; with numerous tables and diagrams. 2000 w. Engineering Magazine—September, 1902. No. 50185 B.

Guards.

Guarding Machinery Against Accidents. Illustrates and describes measures taken by a Brooklyn firm, to guard various points of danger. 700 w. Am Mach—Aug. 21, 1902. No. 50055.

Modern Methods.

Modern Machine Methods. H. F. L. Orcutt. Read before the Inst. of Mech. Engrs. A slightly abridged paper on machine operations, dealing with the latest practice of economical manufacture. Ill. 5300 w. Elect'n, Lond—Aug. 15, 1902. Serial. 1st part. No. 50079 A.

Reducing Valve.

A Large Differential Action Reducing Valve. Illustrates a reducing valve of unusual size which has found a wide variety of applications. 1400 w. Am Mach—Aug. 14, 1902. No. 40083.

Roller Bearings.

See Civil Engineering, Bridges.

Screw Threads.

The Unification of the Pitch of Screw Threads (Note Sur l'Unification des Pas de Vis). T. Payet. A discussion of the metric screw threads for gas pipe and fittings suggesting changes with a view to unification. 4000 w. Bull Soc d'Encour—July 31, 1902. No. 50137 G.

Shop Practice.

The Changes of a Half-Century in the Marine Engine Shop. Egbert P. Watson. An interesting account of early shop practice, and the changes which have gradually been wrought. 4000 w. Engineering Magazine—September, 1902. No. 50187 B.

Standardization.

Standardization in Great Britain. An editorial from the London *Times* dealing with the subject of standardization of engineering and mechanical details. 1700 w. Am Mach—July 31, 1902. No. 49730.

Steel Works.

The Colorado Fuel & Iron Company. An illustrated detailed description of additions and improvements to the Minnequa Works at Pueblo which will make this one of the largest steel plants in the United States. 5600 w. Ir Age—Aug. 14, 1902. No. 49956.

The Newburn Steel Works. History and description of these English works,

with plan. 3000 w. Engng—Aug. 1, 1902. No. 49922 A.

The Rendsburg Steel and Rolling Mills (Das Stahl und Walzwerk Rendsburg). A full detailed description of this important North German works, with numerous illustrations. 4000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Aug 2, 1902. No. 50113 D.

Tempering.

Drawing the Temper. E. R. Markham. Explains the meaning of "temper" and "tempering," and considers points relating to tool hardening. 1000 w. Am Mach—Aug. 14, 1902. No. 49984.

MATERIALS OF CONSTRUCTION.

Abrasives.

Abrasive Materials in the United States. Joseph Hyde Pratt. From advance sheets of Mineral Resources of the U. S., 1901. Information, concerning the natural and artificial abrasives. 2500 w. Stone—May, 1902. No. 49986 C.

Brittleness.

Irregularities in Fragility Tests (De la Discontinuité dans les Essais de Fragilité). H. Le Chatelier. An examination of a number of drop tests of various materials, showing the discontinuous nature of the results, and suggesting that this may be due to the methods of testing. 3000 w. Bull Soc d'Encour—July 31, 1902. No. 50136 G.

Diseases.

Diseases of Iron and Copper (Krankheitserscheinungen in Eisen und Kupfer). E. Heyn. A discussion of the molecular defects in iron and steel, and the methods of detecting them by physical examination. 3500 w. Zeitschr d Ver Deutscher Ing—July 26, 1902. No. 50112 D.

Elastic Limit.

The Determination of the Elastic Limit of Metals (Mesure de la Limite Elastique des Métaux). Ch. Fremont. An examination of the irregularities in the determination of the elastic limit of metals under compression; showing how the limit may be seen in the changes on the surface of a polished test piece. 1000 w. Comptes Rendus—Aug. 4, 1902. No. 50175 D.

MEASUREMENT.

Metric System.

Lord Kelvin on the Metric System. Extracts from remarks before the Committee on Coinage, Weights and Measures of the U. S. House of Representatives, on April 24, 1902. 2800 w. Locomotive—June, 1902. No. 49801.

Torsion Measurements.

Recent Investigations Concerning Dynamical Action in Shafting of Marine Engines, with Special Reference to Synchronous Torsional Vibrations. Hermann Frahm. A description of the experimental plant, researches made, results and conclusions. Illustrations and diagrams. 9300 w. Jour Am Soc of Nav Engrs—Aug., 1902. No. 50204 H.

POWER AND TRANSMISSION.

Belt Driving.

See Electrical Engineering, Generating Stations.

Compressed Air.

Economy Due to Re-Heating Compressed Air. An illustrated account of experimental tests performed by W. G. Edmondson and E. L. Walker, students in the Ry. Engng. Dept. of Cornell Univ. 1500 w. Am Mach—July 31, 1902. No. 49729.

Pipes and Accessories Used in the Transmission of Power by Compressed Air. W. C. Popplewell. Discusses the sources of loss in the present article. Ill. 1800 w. Mech Engr—July 26, 1902. Serial. 1st part. No. 49768 A.

Pneumatic Tubes.

The Boston Pneumatic Tube Service. E. D. Sabine. Describes and illustrates the system for parcel delivery and its mode of operation. 1100 w. R R Gaz—Aug. 22, 1902. No. 50070.

Shafting.

Shafting Hints. Charles Herrman. Suggestions, with illustrations, for the installation, maintenance and repair of shafting. 3400 w. Power—Aug., 1902. No. 49732 C.

Speed Cones.

The Design of Speed Cones and Change Gearing. Alfred Wildgoose. Ivestigates the relation existing between any speed cone and the corresponding gearing used in conjunction with it. 2000 w. Prac Engr—July 25, 1902. No. 49766 A.

Telpherage.

Telpherage. Charles M. Clark. An illustrated article giving the history, construction, method of operation, applications, etc. 3800 w. Jour Assn of Engng Soc's—June, 1902. No. 49715 C.

Variable Speed.

Improved Variable Speed Countershaft. Illustrated description of the improved device made by the Lodge and Shipley Machine Co. of Cincinnati, Ohio. 1400 w. Am Mach—Aug. 21, 1902. No. 50056.

SPECIAL MOTORS.

Alcohol Motors.

The Alcohol Motors at the Berlin Exposition, 1902 (Die Spiritusmaschinen auf der Ausstellung für Spiritusindustrie in Berlin, 1902). R. Schöttler. With details of internal combustion motors for use with methylated spirit; special reference

being had to the carburetters. Serial. Part I. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 2, 1902. No. 50114 D.

See Mechanical Engineering, Automobiles.

Explosion Motors.

The Construction of High Speed Explosion Motors (Construction des Moteurs à Explosions et à Grande Vitesse). Louis Berger. Discussing especially the form of the cams for the operation of the valves. 2000 w. Revue Technique—Aug. 10, 1902. No. 50107 D.

Gas Engines.

Five-Hundred Horse-Power Gas Engine. An illustrated description of a recent type of gas engine, built for using with Mond producer gas. 900 w. Engr, Lond—Aug. 1, 1902. No. 49927 A.

Gas and Gasoline Engine Guarantees. Albert Stritmatter. A consideration of some of the things that affect what may be successfully guaranteed. 2000 w. Am Mfr—Aug. 14, 1902. No. 49974.

Lubrication of Gas Engines. J. D. Lyon. Considers troubles due to insufficient lubrication, and to excessive lubrication. 1500 w. Am Mfr—July 31, 1902. No. 49842.

See Electrical Engineering, Generating Stations.

STEAM ENGINEERING.

Boilers.

Report of the British Admiralty Committee on Naval Boilers. Full report. 11-600 w. Jour Am Soc of Nav Engrs—Aug., 1902. No. 50209 H.

Safe Working Strength of Boilers. Discusses the method of determining a boiler's strength, giving rules and calculations. Ill. 2200 w. Power—Aug, 1902. No. 49733 C.

The Stirling Marine Boiler. Illustrates and describes this boiler, stating its advantages and giving abstract of results of sea trials. 2500 w. Engr, Lond—Aug. 8, 1902. No. 50031 A.

Boiler Supports.

Gallows Frame Supports for Tubular Boilers. C. G. Robbins. An illustrated article discussing details of such a setting. 3700 w. Engr, U S A—Aug. 15, 1902. No. 50002.

Condensation.

Pumping Plant for Condensing Water. Charles Hopkinson. Describes the centrifugal pump and turbine arrangement adopted. 3 plates. 700 w. Inst of Mech Engrs—July 29, 1902. No. 49897 D.

Engines.

Generating Plant, Wolverhampton Exhibition. Illustrated description of a balanced high-speed steam engine representing the latest development of Bever's patent balanced engine, in which all the working parts are absolutely balanced both as regards weights and pressures. 1500 w. Engr, Lond—Aug. 1, 1902. No. 49928 A.

Some Considerations Affecting the Economy of Marine Screw Engines. E. Hall-Brown. Read before the Brit. Inst. of Engrs & Shipbuilders. Discusses mechanical efficiency, drawing conclusions from the results of Prof. Weighton's experiments, and also other points affecting the economy. 2300 w. Naut Gaz—Aug. 21, 1902. No. 50058.

Some Experiments on Steam-Engine Economy. R. L. Weighton. Records the results of two separate and distinct sets of experiments bearing upon the economical performance of the steam-engine. 2 plates. 3000 w. Inst of Mech Engrs—July 30, 1902. No. 49898 D.

3,000 Indicated Horse-Power Vertical Triple-Expansion Engine. Illustrations and dimensions of the largest engine in the Düsseldorf exhibition. 250 w. Engng—Aug. 8, 1902. No. 50036 A.

3,000 Indicated Horse-Power Vertical Triple Expansion Engine. Illustrates and describes further interesting details of this very large engine. 900 w. Engng—Aug. 15, 1902. No. 50090 A.

Feed-Water Filter.

The Harris-Anderson Patent Feed-Water Filter. Illustrated description of an apparatus which it is claimed effects the removal of all oil and leaves the feed-water fit for boiler use. 1700 w. Engng—Aug. 15, 1902. No. 50091 A.

Firing.

Practical Hints on Firing. William Kavanagh. Suggestions for safe and economical firing and care of boilers. Ill. 1900 w. Power—Aug., 1902. No. 49734 C.

Indicators.

Some Indicator Hints. Forrest E. Cardullo. Illustrates and describes the styles of connection in general use, and various devices for reducing motion, giving diagrams showing faults in handling the indicator, and for troubles in the engine. 1800 w. Engr, U S A—Aug. 1, 1902. No. 49824.

Oil Fuel.

See Railway Engineering, Motive Power.

Piping.

Steam Piping (Die Dampfleitung). H. O. Ritschel. A general discussion of the proportions of steam pipes in connection with the distribution of steam from a central station for heating purposes. 4500 w. Gesundheits-Ingenieurs—July 31, 1902. No. 50156 B.

We supply copies of these articles. See page 163.

Power Plant.

Power Plant of the Ansonia, New York, the Largest Apartment House Ever Built. Arthur L. Rice. Illustrated detailed description of a 17-story building, containing 340 suites of apartments, besides stores, restaurants, baths, etc., especially describing the great power plant which furnishes heat, light, refrigeration, telephone service, elevator power, etc., etc. 7000 w. Engr, U S A—Aug. 1, 1902. No. 49823.

Power Plant of the Central Lard Company, Jersey City, N. J. Illustrates and describes a plant particularly interesting as regards power production and transmission. The heating is by steam, the cooling by brine, the lighting and pumping mostly by electricity, and the water supply by means of the air lift. 2000 w. Eng Rec—Aug. 9, 1902. No. 49958.

The University of Chicago Power Plant. Illustrated detailed description of a new central lighting, heating and power generating station which will meet the requirements of 25 separate buildings. 4000 w. Steam Engng—Aug. 10, 1902. No. 49999.

Safety Valve.

A Cause of Steam Boiler Explosions (Sur une des Causes d'Explosion des Chaudières à Vapeur). J. Fournier. Describing an improved form of inward-opening safety valve unaffected by the jet action of the escaping steam. 1200 w. Comptes Rendus—July 28, 1902. No. 50174 D.

Speed Variations.

The Measurement of Variations in Angular Velocity (Ueber ein Neues Verfahren zur Messung des Ungleichformigkeitsgrades und der Winkelabweichung). F. Klönne. The variations of the revolving shaft are plotted upon a uniformly revolving drum in the form of waves. 4500 w. Elektrotech Zeitschr—Aug. 14, 1902. No. 50170 B.

Steam Turbines.

Test of a De Laval Steam Turbine Using Superheated Steam. Details of a series of remarkable tests made by Messrs. Dean & Main, of Boston, upon a 300-brake-horse-power turbine operated at various loads and using saturated and superheated steam. 2300 w. Eng Rec—Aug. 2, 1902. No. 49857.

The DeLaval Steam Turbine (Turbine à Vapeur De Laval). K. Sosnowski. An account of the latest developments of the De Laval steam turbine, with data as to performances of recent installations. 5000 w. Revue de Mécanique—July 31, 1902. No. 50141 E+F.

The Development of the Steam Turbine. An illustrated description of the Trenton, N. J., works of the De Laval Steam Turbine Co., and an account of recent tests of a 300-brake horse-power machine. 3400 w. Elec Rev, N Y—Aug. 9, 1902. No. 49953.

Superheated Steam.

The Practical Economy of Using Superheated Steam. P. Nolet. Translated from the French. Discusses some of the essentials of successful application and gives reasons for the savings effected. 4000 w. Steam Engng—Aug. 10, 1902. No. 50000.

Tests.

Engine Tests. H. F. Schmidt. Remarks applying to practical tests that should be frequently made by the engineer in charge. 1800 w. Am Elect'n—Aug., 1902. No. 49886.

MISCELLANY.

Aeronautics.

Preliminary Project for a Dirigible Balloon (Avant-Projet de Ballon Dirigeable). M. Torres. A paper presented before the French Academy describing a spindle-shaped balloon with an interior keel. 2500 w. Comptes Rendus—July 21, 1902. No. 50172 D.

Project for a Balloon Capable of Crossing the Sahara (Projet d'Aerostats Capable de Traverser le Sahara). Leo Dex. A detailed description of a plan laid before the Minister of War for the construction of a balloon of 1,000 cubic metres capacity, for crossing the Sahara desert. 8000 w. Revue Technique—July 25, 1902. No. 50106 D.

Aluminothermy.

Aluminothermy (Die Aluminothermie). Dr. H. Goldschmidt. A review of the progress which has been made in the utilization of the heat of combustion of aluminum in the industrial arts. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 1, 1902. No. 50145 B.

Heating.

Condensing vs. Exhaust Steam Heating. Charles L. Hubbard. Discusses practical examples, assuming conditions, showing the advantages of the condenser and the obstacles. 1600 w. Am Elect'n—Aug., 1902. No. 49883.

Lubrication.

Force-Feed Lubricators. James F. Hobart. Brief illustrated descriptions of various lubricating devices. 2300 w. Am Elect'n—Aug., 1902. No. 49887.

Oxygen.

The Production of Oxygen by the Fractional Distillation of Liquid Air (Sauerstoffgewinnung mittels Fraktionierter Verdampfung Flüssiger Luft). C. Linde. Professor Linde's paper before the Society of German Engineers, giving details of the

construction of his most recent apparatus. 2000 w. Zeitschr d Ver Deutscher Ing—Aug. 9, 1902. No. 50115 D.

Refrigeration.

An Experience with a Small Ice Machine. R. L. Shipman. Describes a defect in a small refrigerating set and the temporary and permanent remedies. Ill. 1500 w. Ice & Refrig—Aug., 1902. No. 49726 C.

A Model Western Ice Factory. Illustrated detailed description of a new plant at El Reno, Okla., and its power, distilling and freezing equipment. 2000 w. Ice & Refrig—Aug., 1902. No. 49724 C.

Recent Tests of Rrefrigerating Machines in Practical Service (Neuere Versuche an Kühlmaschine Verschiedener Systeme im Praktischen Betriebe). H. Lorenz. With tabulated data and results of a number of machines of the ammonia, sulphurous acid, and carbonic acid types. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 9, 1902. No. 50116 D.

Water Softening and Purifying Systems for Ice Plants. J. C. Wm. Greth. States the advantages of a system of water softening and purifying in ice-making, and describes the We-Fu-Go system. 1500 w. Ice & Refrig—Aug., 1902. No. 49725 C.

Schools.

Ventilating and Heating the Worcester, Mass., High School. Illustrated description of a system using hot water under forced circulation for warming, with air supply for ventilation only. 2000 w. Eng Rec—Aug. 23, 1902. No. 50226.

Smoke Prevention.

The Prevention of Smoke in Porcelain Furnaces (Rauchbelästigung durch den Betrieb von Porzellanbrennöfen). Johann Trnovsky. Discussing the especial conditions which exist in the firing of porcelain, with designs of furnaces for the prevention of smoke. 5000 w. 2 plates. Oesterr Wochenschr f d Oeffent Baudienst—Aug. 2, 1902. No. 50150 B.

Ventilation.

The Ventilation of Domestic Dwellings. E. W. Wagner. Read before the British Inst. of Heat & Ven. Engrs. Discusses points of importance in securing good ventilation. 3000 w. Dom Engng—Aug. 25, 1902. No. 50212 C.

MINING AND METALLURGY

COAL AND COKE.

Appliances.

Mechanical Appliances in Mines. R. H. Wainford. Calls attention to work which may be and is done at the coal face by drills and coal-cutters, as a means of economizing. Ill. 6000 w. Inst of Mech Engrs—July 30, 1902. No. 49893 D.

Coal Fields.

British Columbia: Comox and Quatsino Coal Fields, Vancouver Island. William M. Brewer. Describes these fields and gives table showing the production of coal and coke of Vancouver Island, per year to date. 2000 w. Eng & Min Jour—Aug. 9, 1902. No. 49949.

The Development of the Staffordshire Coalfield. An account of the difficulties met in exploring and the final success. 2000 w. Ir & Coal Trds Rev—Aug. 8, 1902. No. 50040 A.

The Geology of the Crow's Nest Coal Areas. J. McEvoy. An illustrated article describing the formation and estimating the amount of coal in this field, etc. 4800 w. B C Min Rec—Aug., 1902. No. 49933 B.

Coal Washing.

Principles of Coal Washing. Samuel Dieseller. Why and to what extent classifiication as to sizes affects the separation of minerals of different specific gravity. 2500 w. Mines & Min—Aug., 1902. No. 49909 C.

Connellsville.

The Connellsville Region. Howard N. Eavenson. Read before the W. Penn. Cent. Min. Inst. Information concerning its mineral resources, various industries, all of which are overshadowed by the coke industry, its methods by mining, amount of output, etc. 5200 w. Mines & Min—Aug., 1902. No. 49908 C.

Depreciation.

Depreciation of Coal and Coke by Shipment. M. Stelkens. Report submitted to the International Nav. Cong. at Düsseldorf. Considers causes of deterioration, and gives some suggestions for their improvement. 3700 w. Am Gas Jour—Aug. 4, 1902. No. 49827.

Electric Plant.

See Electrical Engineering, Power Applications.

Headstocks.

The Erection of the New Headstocks at the Manners Colliery. Illustrates and describes the headstocks and the work of erection, which was accomplished expeditiously without interfering with the work of the colliery. 1700 w. Ir & Coal Trds Rev—Aug. 8, 1902. No. 50039 A.

We supply copies of these articles. See page 163.

COPPER.

British Columbia.

The Ore Deposits of Copper Mountain, Similkameen District, B. C. O. N. Scott. Gives a description of these ore deposits, discussing their origin, mining and treatment. 2500 w. Can Min Rev—July 31, 1902. No. 49839 B.

California.

Copper in Northern California. J. S. Diller. Describes this copper region which is growing in importance. 1100 w. Min & Sci Pr—Aug. 2, 1902. Serial. 1st part. No. 49938.

Consumption.

Copper Consumption. Editorial concerning the consumption during the first half of the present year. 1000 w. Engng —July 25, 1902. No. 49792 A.

Leaching.

Some Notes on the Leaching of Oxidized Copper Ores. L. J. Charles. Reviews somewhat the history of the copper industry in the United States, the mode and place of occurrence of the ores, and the leaching. 900 w. Min Rept—Aug. 21, 1902. No. 50099.

Ores.

Reformed Copper Ores. J. C. Goodwin. Discusses some of the influences that country or wall rock have upon ores being deposited from the breaking down of the sulphides of copper. 800 w. Min & Sci Pr—Aug. 2, 1902. Serial. 1st part. No. 49937.

GOLD AND SILVER.

Appalachians.

Gold Mining in the Southern Appalachians. Joseph Hyde Pratt. Historical review of the gold-mining industry in this region. 2000 w. Eng & Min Jour—Aug. 23, 1902. No. 50217.

Brazil.

Notes on Brazilian Gold Ores. Orville A. Derby. Considers certain features in the occurrence of gold. 1800 w. Eng & Min Jour—Aug. 2, 1902. No. 49845.

Broken Hill, N. S. W.

The Broken Hill (N. S. W.) Deposits. Discusses the correct geological classification of the lodes, and the accuracy of hypotheses advanced. 2000 w. Aust Min Stand—July 3, 1902. No. 49915 B.

Costa Rica.

The Gold Mines of Costa Rica. Milton Franklin Reitz. The paper aims to give a correct idea of the conservative possibilities of the mining industry in Costa Rica. Ill. 6000 w. Eng & Min Jour—Aug. 16, 1902. No. 50009.

Honneus Process.

De-Sulphurizing Auriferous Ore. Reports a trial of the Honneus process, made at the Great Boulder mine during the month of April. 800 w. Aust Min Stand —June 26, 1902. No. 49912 B.

Klondike.

The Klondike—A Four Years' Retrospect. 2000 w. B C Min Rec—Aug., 1902. No. 49935 B.

Malay Peninsula.

Gold Mining in Malaya. W. Broadbridge. Reports the condition of this industry which is at present under a cloud because of mismanagement. 1500 w. Aust Min Stand—July 3, 1902. No. 49914 B.

Quartz Mining.

The Economy of Electric Power in Quartz Mining. C. O. Poole. Read before the Pacific Coast Elec. Trans. Assn. Presents in a practical way the economical results obtained by the use of electric power in comparison with steam power, using wood, coal and oil as fuel. The paper is based on practice of the mines on the Mother Lode in Amador and Calaveras counties, California. Ill. 4800 w. Jour of Elec—July, 1902. No. 50043.

Rossland.

Mining in the Rossland District. C. M. Campbell. Gives briefly the history of the district, its mining practice, its geology, etc. Ill. 6400 w. Can Min Rev—July 31, 1902. No. 49841 B.

Slimes.

Notes on the Treatment of Slimes by Filter Presses. Clement Dixon. Briefly describes the methods used in Australia and New Zealand. 1800 w. Jour Chem & Met Soc of S Africa—June, 1902. No. 50049 E.

Texas.

The Silver Mine of Texas. Henry M. Adkinson. An illustrated account of the Presidio mine, reviewing its history. 1500 w. Eng & Min Jour—Aug. 2, 1902. No. 49848.

Washington.

The Ore Deposits of Monte Cristo, Washington. J. E. Spurr. An illustrated account of this district, the metals for which ore is especially mined are lead, copper, silver, and gold, though others are found. 1800 w. Eng & Min Jour—Aug. 23, 1902. No. 50216.

IRON AND STEEL.

British Columbia.

British Columbia Iron and Coal. W. M. Brewer. A description of the various known deposits, their locations, qualities, and the extent of development. 4700 w. Mines & Min—Aug., 1902. No. 49904 C.

Census Report.

Census Report on Iron and Steel. Report for the census year 1900, aiming to

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give statistics not available for the Am. Ir & Steel Assn's annual report. 7000 w. Ir Age—Aug. 28, 1902. No. 50229.

Gas Recorder.

Apparatus for Recording the Gas Produced by a Blast Furnace (Registrirapparat zur Ueberwachung der Begichtung der Hochöfen). Dr. Neumark. Describing a form of recording device for indicating the rate of gas discharge from a furnace; thus giving a valuable indication of the combustion performance. 1200 w. Stahl u Eisen—Aug. 1. 1902. No. 50143 D.

Nickel Steel.

Nickel Steel. Much information concerning this valuable alloy, which is growing in use. Ill. 1200 w. R R Gaz—Aug. 8, 1902. No. 49967.

Open Hearth.

Modern Developments in the Production of Open-Hearth Steel. James Christie. Reviews the modern developments in the open-hearth process, stating the advantages claimed and the objections, and describing briefly specific processes. 3300 w. Pro Engrs' Club of Phila—July, 1902. No. 49721 D.

Ores.

Moisture in Lake Superior Iron Ores. N. P. Hulst. Read before the Lake Superior Mining Inst. Discusses whether it will pay to remove partially the excessive moisture before shipping. 1500 w. Ir Age—Aug. 28, 1902. No. 50233.

Pig Iron.

Changes in the Manufacture of Pig Iron as Illustrated by the Development of the American Blast Furnace. John Birkinbine. Reviews the history of the manufacture of iron in the United States, showing the development and progress. Illustrations and discussion. 3800 w. Pro Engrs' Club of Phila—July, 1902. No. 49720 D.

Pyrites Mine.

Pyrites Mine, Red Gulch Creek, Skeena Division. W. F. Best. Illustrated description of a remarkable deposit of iron pyrites. 500 w. B C Min Rec—Aug., 1902. No. 49934 B.

Silicon.

The Influence of Silicon upon Red Shortness (Ueber den Einfluss des Siliciums beim Glühfrischen). A. Ledebur. With tabulated data as to the effect of silicon upon the brittleness of iron at a red heat. 1500 w. Stahl u Eisen—Aug. 1, 1902. No. 50142 D.

Steel.

The Manufacture of Soft Center Steel. G. F. Blackiston. Describes methods of making this steel which is used for plowshares, etc. 1400 w. Ir Age—July 31, 1902. No. 49747.

Steel Works.

See Mechanical Engineering, Machine Works.

MINING.

American Methods.

Some American Mining and Engineering Methods. The present article discusses difference between British and American methods, the American mining schools and laboratories, system of mining education, etc. Ill. 2500 w. Col Guard—Aug. 15, 1902. Serial. 1st part. No. 50086 A.

British Columbia.

Mineral Production of British Columbia in 1901. Statistics condensed from the annual report of the minister of mines. 600 w. U S Cons Repts, No. 1416—Aug. 12, 1902. No. 49901 D.

Mineral Resources and Mining Industry of British Columbia. William M. Brewer. A handsomely illustrated account of the district, describing the gold, copper and other ore deposits in the island sections. 3500 w. Engineering Magazine—September, 1902. No. 50182 B.

Concentration.

The Concentration of Ores by Means of Oil. H. E. T. Haultain. Shows the need of the process and discusses its use, considering also several processes in which oil was used. 2800 w. B C Min Rec—Aug., 1902. No. 49936 B.

Deep Boring.

New Methods of Deep Boring. Illustrates and describes a method which consists in the employment of the flushing water as a medium for conveying motive power to the drilling tool. 2700 w. Ir & Coal Trds Rev—Aug. 15, 1902. No. 50097 A.

Düsseldorf Exposition.

Mining Appliances at the Düsseldorf Exposition (Die Bergmännischen Gewinnungsarbeiten auf der Ausstellung zu Düsseldorf). H. Heise. Giving brief descriptions of various mining appliances exhibited at Düsseldorf, including boring and cutting machinery, explosives, igniters, etc. 3000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—July 19, 1902. No. 50155 B.

Mining at the Düsseldorf Exposition (Der Bergbau auf der Düsseldorfer Ausstellung 1902). Dr. H. Hoffmann. Describing the various forms of cableways cantilevers, and other apparatus for conveying and loading ore, coal, and other mineral exhibited at Düsseldorf. 5000 w. 5 plates. Glückauf—Aug. 9, 1902. No. 50154 B.

Mining at the Düsseldorf Exposition (Der Bergbau auf der Düsseldorfer Ausstellung 1902). H. Fändrich. Describing especially the exhibits relating to explo-

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sives, igniting devices and safety lamps. 7500 w. 2 plates. Glückauf—July 26, 1902. No. 50152 B.

Mining at the Düsseldorf Exhibition. Remarks on the various districts giving general particulars, and calling attention to some of the objects of interest to mining engineers. 3200 w. Engr, Lond—July 25, 1902. Serial. 1st part. No. 49785 A.

Mining at the Düsseldorf Exposition (Der Bergbau auf der Düsseldorfer Ausstellung 1902). H. Herbst. Discussing the exhibits of boring and cutting machines and rock drills, with many illustrations. 7500 w. 4 plates. Glückauf—Aug. 2, 1902. No. 50153 B.

Electric Haulage.

See Electrical Engineering, Power Applications.

Electric Plant.

See Electrical Engineering, Power Applications.

Exhibition.

Mining Machinery at the Wolverhampton Exhibition. Illustrates and describes interesting exhibits. 1400 w. Col Guard—July 25, 1902. Serial. 1st part. No. 49783 A.

Explosives.

Accidents in the Use of Blasting Explosives. Remarks of H. M. Inspectors of Explosives on each class of accidents, as given in a recent report. 1700 w. Col Guard—July 25, 1902. No. 49784 A.

The Testing of Explosives for Use in Coal Mining. Information from the report of H. M. Inspector, concerning the working of the testing apparatus, the explosives that failed to pass the test, etc. 1400 w. Col Guard—Aug. 1, 1902. No. 49929 A.

Firedamp.

The Fernie Colliery Explosion. A discussion of this disaster at the Fernie Coal Mines in British Columbia, which occasioned the death of 130 men or more, on May 22, 1002. 2300 w. Col Guard—July 25, 1902. No. 49782 A.

The Sudden Disengagement of Firedamp (Les Dégagements Instantanés de Grisou). Henri Ghysen. A general discussion of the formation and disengagement of explosive gases in mines, with data from numerous instances in practice. 12000 w. 2 plates. Rev Univ des Mines—July, 1902. No. 50134 H.

Haulage.

Different Methods of Mine Haulage Compared. B. F. Jones. Considers the good and bad methods found as parts of all systems. Ill. 7000 w. Mines & Min—Aug., 1902. No. 49906 C.

Mexico.

Through the Sierra Madres in Chihuahua, Mexico. George D. James. An account of the mining camps, description of the country, and general information. Ill. 3800 w. Eng & Min Jour—Aug. 2, 1902. No. 49844.

Power Drills.

Power Drills. C. C. Hansen. An illustrated description of some of the better known types. 1700 w. Can Min Rev—July 31, 1902. No. 49838 B.

Prospecting.

Hints to Prospectors. W. J. Adams. Showing that deposits of value are often overlooked, and urging the saving of unknown crystals, with data of their locality. 1200 w. Min & Sci Pr—Aug. 2, 1902. No. 49939.

Pumps.

Cornish Pumps. Prof. W. R. Crane. Considers their construction and method of operation as illustrated in the Galena-Joplin District, Missouri. Ill. 2500 w. Mines & Min—Aug., 1902. No. 49907 C.

Quarries.

Karlshäll Granite Quarries, Carlshamn, Sweden. An illustrated detailed description of this famous granite district. 4600 w. Quarry—Aug., 1902. No. 49980 A.

Shaft Sinking.

The Application of Suspended Steam-Pumps to the Sinking of Deep Shafts. W. Price Abell. An illustrated article endeavoring to show the advantages when suitable pumps, tackle, winches, etc., are used. 1800 w. Ir & Coal Trds Rev—July 25, 1902. No. 49799 A.

The Sinking of Shafts in Water Bearing Strata (Les Creusements de Puits en Morts-Terrains). A. Habets. Discussing especially the devices for sinking shafts shown at the Düsseldorf exposition including the methods of Tomson, Sassenberg and Clermont, and Pattberg. 8000 w. 3 plates. Rev Univ des Mines—July, 1902. No. 50135 H.

Timbering.

Mine Timbering in the Old Ironsides and Knob Hill Mines. H. P. De Pencier. An illustrated description of extensive timbering made necessary by the immense size of the ore bodies. 3500 w. Can Min Rev—July 31, 1902. No. 49840 B.

Square Sett Timbering. T. O. Renowden. Describes the timbering of the Ophir mine, U. S. A., and at Broken Hill, N. S. W. 1500 w. Aust Min Stand—June 19, 1902. No. 49911 B.

Winding Engines.

Electrically-Driven Winding Engines. Illustrated description of an engine for a Dortmund mining company which will

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haul from a depth of 2,296 feet, 100 tons of coal per hour. Also of another type to be used in Saxony, which hauls in a ten hours' shift, from 600 to 700 tons of coal from a depth of 722 feet. 1500 w. Engng—Aug. 1, 1902. No. 49923 A.

Electrically Operated Hoisting Plants (Förderanlagen mit Elektrischem Antrieb). O. Lasche. With detailed illustrations of several hoists, showing the wiring, and method of control. 2500 w. 1 plate. Glückauf—July 19, 1902. No. 50151B.

Double Tandem Winding Engine (Zwillings-Tandem-Fördermaschine). A. Deeg. A detailed description of the new winding engine with double spiral drums recently built for the coal mines at Rouchamp, France, by the Humboldt Machine Works at Kalk. 4000 w. 1 plate. Zeitschr d Ver Deutscher Ing—July 19, 1902. No. 50108 D.

MISCELLANY.

Aluminum.

Process for Extracting Aluminum. Describes the process and gives information regarding the production, values, consumption, etc. 1200 w. Am Mfr—July 31, 1902. No. 49843.

Asbestos.

Mining Asbestos in Canada. W. Mollman. States the principal localities giving information concerning the methods of mining, appliances used, treatment, etc. 900 w. Min & Sci Pr—July 26, 1902. No. 49835.

California.

Mineral Production of California for 1901. Report of the state mineralogist, with much information of interest. 2000 w. Eng & Min Jour—Aug. 9, 1902. No. 49950.

Cuba.

See Industrial Economy.

Diamonds.

Diamonds and Carbons in Bahia. Information concerning the deposits, method of mining, labor conditions, state regulations, method of selling, etc. 4300 w. U S Cons Repts, No. 1423—Aug. 20, 1902. No. 50042 D.

Manganese.

A New Departure in Manganese Mining. J. S. C. Wells. Describes the washing out of the ore by hydraulic methods, similar to those used for gold. 500 w. Eng & Min Jour—Aug. 2, 1902. No. 49846.

The Manganese Deposits of Santiago Province, Cuba. Arthur C. Spencer. Gives the location of deposits thus far worked, describing the ores, mode of occurrence, geology, etc. Ill. 2300 w. Eng & Min Jour—Aug. 23, 1902. No. 50218.

Petroleum.

Oil in Book Cliff Region of Colorado. A description of the formations near Rifle Creek, showing oil signs. 2400 w. Mines & Min—Aug., 1902. No. 49905 C.

The Beaumont Oil Field, with Notes on Other Oil Fields of the Texas Region. Robert T. Hill. Gives much information concerning the occurrences of oil, describes the geology of the Texas region, etc. Ill. 5000 w. Jour Fr Inst—Aug., 1902. Serial. 1st part. No. 49819 D.

The Fort Steele Oil Field. J. C. Kennedy. A preliminary report giving information of the oil-bearing rocks of Wyoming. 1600 w. Min Rept—Aug. 7, 1902. No. 49932.

Platinum.

Microscopic Effects of Stress on Platinum. Thomas Andrews and Charles Reginald Andrews. Experiments are described, with illustrations, showing the behavior of this metal. 800 w. Engng—July 25, 1902. No. 49795 A.

Tin.

Red River Tin Stream, Cornwall. Edward Skewes. An illustrated article discussing the mode of operation of the these English tin mines, the loss of tin, etc. 2900 w. Eng & Min—Aug. 9, 1902. No. 49948.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Government Accident Bulletin Number 3. The report of the Interstate Commerce Commission summarizing the collisions, derailments and casualites during the three months ending March 31. 1500 w. R R Gaz—Aug. 1, 1902. No. 49761.

Train Accidents in the United States in June. Classified list. 2500 w. R R Gaz—Aug. 1, 1902. No. 49760.

Collisions.

Forty-one Rear Collisions. Editorial discussing the Government reports, Bulletins No. 2 and No. 3, and the causes of the collisions. 1500 w. R R Gaz—Aug. 22, 1902. No. 50071.

Fast Run.

A Twentieth Century Run. An account of a run of 133.9 miles at 69.3 miles per hour, to make up time lost by the tracks being blocked by a wreck. 800 w. Am

Engr & R R Jour—Aug., 1902. No. 49-833 C.

Per Diem.

A Question to be Decided in Connection with Per Diem Agreements. Editorial discussion of the question where state laws grant to shippers a specific number of days for loading and unloading. 1700 w. R R Gaz—Aug. 15, 1902. No. 49994.

Switzerland.

Statistics of Swiss Railways (Aus der Schweizerischen Eisenbahnstatistik). With comparative tables, showing the development of Swiss railways in 1898, 1899, and 1900. 2500 w. Schweizerische Bauzeitung—July 10, 1902. No. 50122 B.

Train Service.

Birmingham to London in One Hour, Fifty-five Minutes. Describes the successful run of a new train on the London and North Western. 800 w. Engr, Lond —Aug. 8, 1902. No. 50034 A.

FINANCIAL.

Purchase.

The Eastern Illinois Purchase. Editorial discussion of the purchase of the Chicago & Eastern Illinois R. R. by the St. Louis & San Francisco R. R. Co. 2000 w. R R Gaz—Aug. 15, 1902. No. 49995.

MOTIVE POWER AND EQUIPMENT.

Car Lighting.

Car Lighting by Acetylene and Electricity. Extracts from the address of L. T. Canfield before the M. C. B. Association at Saratoga. 1500 w. Am Engr & R R Jour—Aug., 1902. No. 49834 C.

Cars.

A New Method of Steel Car Construction. Plan and elevation drawings, with detail views of a design of car which is the invention of H. C. Hodges. The claim is that a lighter, cheaper, simpler steel frame car is shown which will compare favorably in strength with any of the present forms. 1400 w. Ry & Engng Rev—Aug. 2, 1902. No. 49836.

New Vestibule Coaches on the C. R. R. of N. J. Very handsome coaches are illustrated and described. 400 w. Loc Engng Aug., 1902. No. 49881 C.

The Constructive Features of the Goodwin Car. John M. Goodwin. Describes the special features of this car. 1600 w. R R Gaz—Aug. 8, 1902. No. 49968.

Unique Design for Combined Sleeping and Parlor Car. Brief description of the Holland patent, which gives a compartment sleeping car for night service, and an open parlor car for day travel, with partitions that can be easily operated. 700 w. Ry & Engng Rev—Aug. 16, 1902. No. 50005.

Instruction Car.

Air Brake Instruction Car on the N. Y. C. & H. R. R. R. Illustrations showing details of construction and the general interior arrangement, with description. 700 w. Ry & Engng Rev—Aug. 9, 1902. No. 49941.

Locomotives.

Canadian Ten-Wheeler. Illustration and principal dimensions of a passenger engine designed to haul transcontinental trains. 900 w. Loc Engng—Aug., 1902. No. 49880 C.

Four-Wheel Coupled Three-Cylinder Compound Locomotive. Illustrated description of an engine for passenger service on the Midland Railway, England. 800 w. Engng—Aug. 15, 1902. No. 50-093 A.

Metre-Gauge Locomotive. Drawings, photographs and description of a 12-wheel coupled compound duplex tank locomotive designed and built on the Mallet system. 500 w. Engng—Aug. 1, 1902. No. 49924 A.

Metre-Gauge Fairlie Engines for the Burma Railway Company. Illustrates and describes the most modern form of these engines. 2200 w. Sci Am Sup—Aug. 16, 1902. No. 49997.

New Six-Coupled Passenger Locomotive. Illustration and general dimensions of a design for the Missouri Pacific Railway. 800 w. Am Engr & R R Jour—Aug., 1902. No. 49832 C.

Passenger Engines for the Chesapeake & Ohio and the Missouri Pacific. Illustrates and describes the notable features of two engines, giving general description. 600 w. R R Gaz—Aug. 1, 1902. No. 49-759.

Recent Progress in Locomotive Construction (Neuere Fortschritte im Lokomotivbau). H. v. Borries. A review of the recent developments in locomotive work, including superheating, compounding, improved materials, etc. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—July 19, 1902. No. 50109 D.

Six-Wheel Connected Passenger Locomotive for the C. & O. Ry. Illustrated description of mountain type passenger engines for fast service under exacting conditions. 900 w. Ry & Engng Rev—Aug. 2, 1902. No. 49837.

Ten-Wheel Passenger Locomotives for the Mexican National Ry. Illustrations with description of recently completed engines designed for burning bituminous coal. 1000 w. Ry & Engng Rev—Aug. 23, 1902. No. 50214.

The Distribution of Work in Compound Locomotives (Répartition du Travail dans les Machines Compound). G. Mohr. An examination of the steam distribution in compound locomotives for

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various positions of the link. 1000 w. Génie Civil—Aug. 2, 1902. No. 50103 D.

The First Successful Coal Burner and Its Modern Successor. Two illustrations, with an account of the introduction of coal for locomotive fuel. 1100 w. Loc Engng—Aug., 1902. No. 49879 C.

Oil Fuel.

The Application of Masut on the Russian Railways (Application du Mazout au Chauffage des Locomotives Russes). H. Guérin. Describing the apparatus used for burning the petroleum residues of Southeastern Russia. 1200 w. Génie Civil—Aug. 9, 1902. No. 50105 D.

Rolling Stock.

New Rolling Stock, Midland Great-Western Railway of Ireland. Describes new rolling-stock, giving illustrations of new locomotives. 1200 w. Engr, Lond—July 25, 1902. No. 49786 A.

Valve Gear.

A New Valve Gear for Compound Locomotives (Neue Steuerung für Verbundlokomotiven). M. Kuhn. With diagrams of an improved form of straight-link motion, and indicator cards showing the steam distribution. 3000 w. Zeitschr d Ver Deutscher Ing—July 26, 1902. No. 50111 D.

Valves

The Application of Cylindrical Steam Distributing Valves to Locomotives. Walter M. Smith. Gives illustrated descriptions of valves tried, and much information concerning the working of engines fitted with them, their action under different conditions, etc. Ill. 6000 w. Inst of Mech Engrs—July 30, 1902. No. 49894 D.

Weight Distribution.

A Diagram for Axle Loading and Its Application to Locomotives (Das Diagramm der Achsbelastung und Seine Anwendung bei Drei und Mehrachsigen Lokomotiven). J. Kempf. A graphical and analytical examination of the distribution of weights in locomotives by means of equalizing levers. 1200 w. Glasers Annalen—Aug. 1, 1902. No. 50121 D.

NEW PROJECTS.

Africa.

The Cape to Cairo Railway. An interesting account of the progress and present condition of this railway, the rolling stock, business, etc. 1200 w. Engr, Lond—Aug. 1, 1902. Serial. 1st part. No. 49926 A.

Bagdad.

The Bagdad Railroad. D. G. Hogarth. Extract from an article in the *National Review*, London, giving the history of this project. 1800 w. R R Gaz—Aug. 8, 1902. No. 49979.

Ecuador.

The Guayaquil & Quito Railway of Ecuador. An illustrated historical account of this interesting piece of railway construction, with information concerning elevation and the character and number of bridge structures. 1500 w. Ry Age—Aug. 8, 1902. No. 49942.

Mountain Railway.

The Lötschberg Railway (Die Lötschbergbahn). An account of the topography and route of the proposed railway and tunnel, over the Lötschberg, Switzerland. The tunnel will be 8½ miles long. Serial. Part I. 2000 w. Schweizerische Bauzeitung—Aug. 9, 1902. No. 50124 B.

Salt Lake.

The Railroad Through Salt Lake. Illustrations and description of novel methods used in the construction of the Ogden-Lucin cut-off of the Southern Pacific. The present article deals with the construction in shallow water. 1300 w. Ry Age—Aug. 15, 1902. No. 50004.

PERMANENT WAY AND FIXTURES.

Car Hoist.

See Electrical Engineering, Power Applications.

Engine-House.

B. & O. Standard Engine-House and Machine Shop, at Fairmont, W. Va. Illustrated detailed description. 600 w. R R Gaz—Aug. 1, 1902. No. 49758.

Frost Action.

Disturbance of Roadbed and Bridges by Frost on the Trans-Siberian Railway. Illustrated description of interesting phenomena observed on this line in Siberia. 500 w. Eng News—July 31, 1902. No. 49754.

Power Plant.

The Power Plant of the New Union Station. D. B. Kinch. Describes the power plant of the new station of the Pennsylvania R. R. at Pittsburg, Pa. 3000 w. Pro Engrs Soc of W Penn—July, 1902. No. 50202 D.

Re-building.

The Re-building of the Baltimore & Ohio Railroad. Gives an outline of the general scheme, and an illustrated account of the proposed reconstruction work. 4000 w. R R Gaz—Aug. 22, 1902. No. 50068.

Shops.

The Omaha Railway Shops at Saint Paul. An illustrated description of the extensive improvements made in the St. Paul shops to furnish better facilities for rolling-stock maintenance. 1600 w. Ry Age—Aug. 22, 1902. No. 50213.

Signalling.

A Description of the Westinghouse Electro-Pneumatic Interlock Switch and

We supply copies of these articles. See page 163.

Signal System Installed in the Yards of the Pennsylvania Union Station, Pittsburg, Penna., by the Union Switch and Signal Company. J. G. Schreuder. Ill. 5000 w. Pro Egrs Soc of W Penn—July, 1892. No. 50203 D.

A New Safety Signal System for Repeating Railway Danger Signals Visibly and Audibly in the Locomotive Cab. From *La Nature*. Illustrates and describes an invention of Capt. Netter, the object of which is to reproduce in the engineer's cab the signals seen along the track. 1800 w. Sci Am Sup—Aug. 2, 1902. No. 49751.

Electric Interlocking at Bridge Junction. Illustrates and describes a plant in Illinois having features of particular interest, one of the switches being a mile from the cabin. 1200 w. R R Gaz—Aug. 15, 1902. No. 49992.

Fog Signaling. A study of ten accidents on British railways due to fogs, and how to prevent the ignoring of danger signals. Shows the difficulties to be overcome. 2400 w. Engr, Lond—Aug. 15, 1902. No. 50087 A.

Interlocking Switch Towers (Cabines d'Enclenchements). M. Cossmann. A discussion of the arrangement of the tower for a number of levers as illustrated by the station at Amiens, and elsewhere in France. 3500 w. Rev Gen d Chemins de Fer—Aug., 1902. No. 50139 H.

Modern Electric Block Signaling. E. F. Bliss. Abstract of a thesis presented for graduation at the Univ. of Nebraska. Outlines some of the more important features of present automatic block-signal practice. Ill. 4800 w. Elec Wld & Engr—Aug. 23, 1902. No. 50219.

The Progress of Block Signaling on American Railways. Editorial review of a report of the Committee on Safety Appliances of the Am. Ry. Assn. 2000 w. Eng News—Aug. 21, 1902. No. 50066.

Terminal Equipment.

The Mechanical and Electrical Equipment of the Pittsburg & Lake Erie Railroad Tunnel, Pittsburg. An illustrated description of apparatus for warming and ventilating, lighting, power, etc. The equipment consists of boilers and stokers, coal and ash-handling plant, electric generating sets, air compressors, water distilling and refrigerating plant, pumping plants, etc. 2500 w. Eng Rec—Aug 2, 1902. Serial. 1st part. No. 49856.

Tunnels.

See Civil Engineering, Construction.

Union Station.

Construction, Design, etc., of the New Union Station for the Pennsylvania Railroad, Pittsburg, Pa. J. G. Giaver. Briefly reviews the progress in construction of business buildings, during the last 20 years, and gives an illustrated description of the design, construction work, etc., of this station which combines the features of a modern office building and a station. 4000 w. Pro Engrs Soc of W Penn—July, 1902. No. 50201 D.

The New Union Station P. R. R., Pittsburg, Pa. G. C. Clark. An illustrated article dealing with the location, preparation of site, approaches, elevated tracks and train sheds. 5000 w. Pro Engrs Soc of W Penn—July, 1902. No. 50200 D.

Viaducts.

See Civil Engineering, Bridges.

TRAFFIC.

Freight.

A Novel and Important Freight Contract. A slightly abridged copy of a circular issued by A. B. Stickney, giving particulars of a contract just made with the beef shippers. 2500 w. R R Gaz—Aug. 15, 1902. No. 49991.

MISCELLANY.

International Congress.

Subjects and Reporters—International Railway Congress. Gives the questions and reporters for the seventh session of this Congress, which will be held in Washington, D. C., May, 1905. 1500 w. R R Gaz—Aug. 22, 1902. No. 50069.

STREET AND ELECTRIC RAILWAYS

Accounting.

See Industrial Economy.

Berlin.

The Metropolitan Railway of Berlin (Le Chemin de Fer Metropolitain Electrique de Berlin). A general description of the electric elevated railway in Berlin, with views of the important bridges and other structures. 8000 w. Rev Gen d Chemins de Fer—Aug., 1902. No. 50140 H.

Berlin-Zossen.

Results of the Tests on the Berlin-Zossen Experimental High-Speed Line. Extracts from a paper by Geheimer Baurath Lochner, printed in *Glasers Annalen*, giving new information not before published. 2800 w. St Ry Jour—Aug. 2, 1902. No. 49864 D.

Brakes.

Power Brakes for Street Cars. Report prepared by a committee for the Board of

Public Improvements in St. Louis. 1500 w. R R Gaz—Aug. 1, 1902. No. 49757.

Car Driving.

Lecture on Electric Car Driving. E. W. Elsley. A lecture to be given horsemen, enginemen and the novice on their first attendance for tuition in electric car driving. 1800 w. Elec Engr, Lond—Aug. 8, 1902. No. 50026 A.

Cars.

Convertible Cars. W. E. Partridge. Illustrates and describes the forms of railway cars which aim to combine the leading features of open and closed cars. 1800 w. St Ry Rev—Aug. 20, 1902. No. 50228 C.

Chicago.

Loop Terminals and Transfer Station; Metropolitan Elevated R. R., Chicago. States the advantages of loop terminals, and gives plans and description of recent work in this city. 1300 w. Eng News—Aug. 14, 1902. No. 49990.

Collisions.

Runaway Trolley Cars. Editorial discussion of the recent accident at Gloversville, N. Y., and the operation of electric roads in general. 3000 w. R R Gaz—Aug. 1, 1902. No. 49763.

Despatching.

Interurban Car Despatching. Suggestions relating to a system for using the telephone, reviewing methods in present use. 2000 w. St Ry Jour—Aug. 2, 1902. No. 49869 D.

Electric Locomotives.

Electric Locomotives. Waldon Fawcett. Information concerning these engines of the storage battery type, stating their economic advantages. Ill. 1200 w. Loc Engng—Aug., 1902. No. 49878 C.

High Speed Locomotive (Schnellbahn-Lokomotive). W. Reichel. Describing the Siemens & Halske locomotive operating at 10,000 volts pressure on the Berlin-Zossen high speed military railway. 6000 w. Elektrotech Zeitschr—Aug. 7, 1902. No. 50167 B.

Electrification.

Electrification on the North Eastern Railway. Facts from the specifications concerning the change to electric power on one of the branches of this railway. Map. 2500 w. Engng—Aug. 15, 1902. No. 50094 A.

Electro-Pneumatic.

New Electro-Pneumatic System of Electric Railway Construction. Bion J. Arnold. A brief description of the writer's system with a statement of the results he believes will be accomplished by its adoption. 1500 w. Trans Am Inst of Elec Engrs—May, 1902. No. 50235 D.

European Practice.

Some Notes on European Practice in Electric Traction with Three-Phase Alternating Currents. Carl L. de Muralt. Brief description of typical roads using polyphase alternating currents, results of tests, etc. Ill. 7700 w. Trans Am Inst of Elec Engrs—April, 1902. No. 49811 D.

Express Trains.

The Express Train of the Future. Describes certain features of the new locomotives which are to be tested on the Berlin-Zossen line next year. 900 w. U S Cons Repts, No. 1415—Aug. 11, 1902. No. 49849 D.

Feeders.

The Distribution of Current in Railway Systems (Stromvertheilung auf Eisenbahnnetzen). Ph. Pforr. Developing a graphical method by which the distribution can be shown both for direct and branching circuits. 3000 w. Elektrotech Zeitschr—July 24, 1902. No. 50160 B.

Finance.

Electric Traction Finance. Editorial on the annual report of the working of the Glasgow tramways. 700 w. Engng—Aug. 8, 1902. No. 50037 A.

Interurban.

High-Speed Interurban Electric Railways. George H. Gibson. A highly illustrated discussion of the recent phenomenal development of interurban electric railways, with numerous examples of important roads. 5000 w. Engineering Magazine—September, 1902. No. 50184 B.

The System of the Youngstown-Sharon Railway and Light Company. Illustrated description of a recently opened line which is a good example of modern construction. 2000 w. St Ry Jour—Aug. 2, 1902. No. 49863 D.

Ireland.

The Sutton and Howth Tramway. Illustrated description of a line which gives a fine view of Dublin Bay. 1800 w. St Ry Jour—Aug. 2, 1902. No. 49870 D.

Italy.

The Ventimiglia-Bordighera Electric Tramway. Enrico Bignami. Brief illustrated description. 500 w. Elec Rev, N Y—Aug. 16, 1902. No. 49981.

London.

The Electrification of London. Concerning the bills before the British parliament, giving details of the schemes, and a summary of the route and points of interest of the different lines. Map. 2700 w. Nature—July 24, 1902. No. 49764 A.

Marseilles, France.

The Electric Tramways of Marseilles (Tramways Electriques de Marseille). Especially describing the central gener-

We supply copies of these articles. See page 163.

ating station and transforming apparatus. 3000 w. 1 plate. Génie Civil—Aug. 9, 1902. No. 50104 D.

The Electric Tramways of Marseilles (Tramways Electriques de Marseille). M. Denizet. A detailed description of the entire plant with map of the city and plans of the station and equipment. 8000 w. 4 plates. Ann des Ponts et Chaussées —1 Trimestre, 1902. No. 50127 E+F.

Motor Testing.

See Electrical Engineering, Measurements.

Power Station.

The Central Power Station of the Glasgow Municipal Electric Tramways. Illustrated detailed description of this station and its equipment. 3500 w. Power—Aug., 1902. No. 49731 C.

Repair Shops.

New Repair Shops of the Rhode Island Suburban Railway. Illustrated description of the arrangement and equipment of these shops for the repairing of the rolling stock of the street railway system. 1200 w. Eng Rec—Aug. 2, 1902. No. 49861.

Short Railway.

A Unique Railway. C. E. Price. Brief description, with illustrations of the "Angel's Flignt" in Los Angeles, Cal. It is 350 feet in length and rises 100 feet. It is built on the three-rail automatic turnout system. 500 w. Sci Am—Aug. 9, 1902. No. 49874.

Signals.

Block Signal Systems for Electric Railways. H. D. Emerson. Showing the adaptability of the block system, and its application by means of the "train staff," to high speed electric railways. 2000 w. St Ry Jour—Aug. 16, 1902. No. 50007 D.

Stray Currents.

Electrolysis in Water-Pipes. W. H. Humphreys. Read before the Brit. Assn. of W. Wks. Engrs. Presents facts relating to the injury of pipes from electrolytic action, giving extracts from the Board of Trade regulations. 6500 w. Elec Engr, Lond—Aug. 8, 1902. No. 50024 A.

History of the Electrolysis Question. W. H. Humphreys. Extracts from a paper and discussion at the annual meeting of the British Assn. of Water-Works Engrs. Presents facts relating o the action on gas and water pipes. 7500 w. Jour Gas Lgt—Aug. 5, 1902. No. 49978 A.

Injury to Metal Pipes by Electric Railways (Gefährdung von Metallrohrleitungen durch Elektrische Bahnen). R. Ulbricht. Giving the results of measurements of electric leakage in Dresden and in Leipsig, and the corrosion of water pipes in both cities. 2000 w. Elektrotech Zeitschr—Aug. 14, 1902. No. 50171 B.

See Gas Works Engineering.

Suburban.

The Aurora, Elgin & Chicago Railway. An illustrated detailed description of an important suburban electric railway, covering the most populous suburban districts of Chicago. Also describes the equipment, rolling stock, etc. 8000 w. St Ry Rev—Aug. 20, 1902. No. 50227 C.

Surface Contact.

The Cruvellier Surface Contact System. Illustrates and describes a new system that has been tested at Neuilly, near Paris, and which claims to have overcome some of the disadvantages of other contact systems. 2000 w. Engng—Aug. 15, 1902. No. 50092 A.

Third Rail.

The Electric Third Rail. W. B. Potter. Illustrates and describes a third-rail protection which is simple and effective. It consists of a channel of iron or plank supported by brackets directly over and about 2½ inches above the third rail. 1400 w. St Ry Jour—Aug. 2, 1902. No. 49865 D.

Through Traffic.

Through Traffic on Tramways for Passengers and Goods. J. E. Waller. Read before the Liverpool Chamber of Commerce. Also editorial. Advocating through traffic wherever possible and showing the advantages of a large system of tramways. Discusses methods and conditions. 5200 w. Elec Engr, Lond—July 25, 1902. No. 49775 A.

Trolley Omnibus Line.

Trolley Omnibus Line Between Nice and Upper Monte Carlo. Presents the advantages of the auto-trolley system in many places, and gives an illustrated description of the system to be installed on this line. 3000 w. St Ry Jour—Aug. 2, 1902. No. 49871 D.

Versailles.

Electric Traction on the Line From the Invalides to Versailles (La Traction Electriques sur la Ligne des Invalides à Versailles). M. Mazen. A general description of the power house, transformers, and locomotives, with a plan of the line. 5000 w. Rev Gen d Chemins de Fer—Aug., 1902. No. 50138 H.

Wear.

Notes on the Wear and Maintenance of Tramways. C. F. Wike. Read before the Assn. of Munic. & Co. Engrs. Statistics and information concerning the wear of electric tramways, from observations made of the tramways of Sheffield, Eng. Ill. 1800 w. Elec Engr, Lond—July 25, 1902. No. 49773 A.

We supply copies of these articles. See page 163.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manuf. and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.

Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* Londo...
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Klijk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Arches.

Theory of Steel-Concrete Arches and of Vaulted Structures. By William Cain, M. Am. Soc. C. E. Size, 3¾ in. by 6 in.; pp. 181; plate, 1; figures, 24. Price, 50 cts. New York: D. Van Nostrand Company.

This is the second edition of one of the Van Nostrand science series, by the professor of mathematics in the University of North Carolina, about one-half of the present book being entirely new. This work contains a complete solution, graphical and analytical, of the elastic arch of variable section. The arch of steel and concrete combined has been taken up in detail to illustrate the general graphical treatment. Culverts and tunnel arches, groined and cloistered arches and domes of masonry are also discussed. The aim throughout has been to give a clear analysis of the principles involved, a knowledge of the fundamental principles of the equilibrium polygon being alone assumed.

Armature Windings.

Armature Windings of Direct Current Dynamos; Extension and Application of a General Winding Rule. By E. Arnold. Translated from the original German by Francis B. De Gress, M. E. Size, 6 in. by 9½ in.; pp. VI, 124; figures, 146. Price, $2.00. New York: D. Van Nostrand Company.

This is a translation, by the chief of the testing department of the Crocker-Wheeler Company, of the German treatise by the assistant professor of electrotechnics and machine design at the Riga Polytechnic School. Starting with fundamental principles, the author developes a general formula applicable to all direct-current armature windings. This rule not only embraces all known windings, but accomplishes even more: a general solution of the winding problem. By the aid of this rule and in conjunction with the various methods of connecting inductors which are shown, it is possible to design other windings. The work is very fully illustrated with winding diagrams, and contains a large number of designs, including many of historic interest.

Civil Engineering.

Civil Engineering as Applied in Construction. By Leveson Francis Vernon-Harcourt, M. A., M. Inst. C. E. Size, 6 in. by 9 in.; pp. XV, 624; illustrations, 368. Price, $5.00. London, New York and Bombay: Longmans, Green and Co.

This book treats of the principles involved in the different branches of civil engineering construction, and illustrates the methods by which these principles receive their practical application by describing a great variety of works. Different sections are devoted to materials, preliminary works, foundations and roads; railway, bridge and tunnel engineering; river and canal engineering, and irrigation works; dock works and maritime engineering; sanitary engineering. The volume is well illustrated, has a full index which gives a concise indication of the purport of each reference, and gives a comprehensive survey of the best practice and greatest works in the whole field of civil engineering.

Drawing.

Self-Help Mechanical Drawing; An Educational Treatise. By N. Hawkins, M. E. Size, 10 in. by 6½ in.; pp. 299; figures, 314. Price, $2.00. New York: Theo. Audel & Co.

The purpose of this book is to aid the aspiring student in making the first advance towards a thorough and useful knowledge of drawing in its several divisions, and to this end the subject has been treated in minute detail and profusely illustrated. Sections are devoted to chalk work, free-hand drawing, geometrical drawing, materials and instruments, mechanical drawing, lettering, dimensioning, shading, section lining and colors, drawing-office rules, patent drawings, perspective and various other matters, and the book is concluded with a number of useful tables and a reference index.

Electrical Calculations.

Electrical and Magnetic Calculations for the Use of Electrical Engineers and Artisans, Teachers, Students and All Others Interested in the Theory and Application of Electricity and Magnetism. By A. A. Atkinson, M. S. Size, 5 in. by 7 in.; pp. VII, 310; figures, 45. Price, $1.50. New York: D. Van Nostrand Company.

This book is the outgrowth of several years of experience in teaching young men

the rudiments of electricity, the author being a professor in Ohio University, and a large part of the matter was, in fact, prepared especially as an introduction to a course in electrical engineering. Different branches of the subject are taken up in the dozen chapters, and after the laws and formulæ have been developed, examples are worked out, illustrating the application of the principles, and giving familiarity with the processes. The book is well illustrated and has an index.

Electrical Catechism.

The Electrical Catechism. 533 Plain Answers to 533 Practical Questions about Electrical Apparatus, Compiled from the Regular Issues of *Power*. Size, 5½ in. by 9 in.; pp. 210; figures, 246. Price, $2.00. New York: Hill Publishing Company.

A very good practical book. The author has not attempted to cover the entire electrical field, but has treated the principles and practice of "heavy-current" electrical engineering in a clear and concise manner which will appeal particularly to the central-station or isolated-plant engineer, but will also be a helpful review for the engineering student. The book is fully illustrated and has an index.

Electric Driving.

Les Moteurs Electriques dans les Industries à Domicile. A report made to the Belgian Minister of Industry and Labor, by Ernest Dubois and Armand Julin. Size, 6½ in. by 10 in.; pp. 292. Paper covers.

This book contains the results of an examination of the mechanical, economic and social effects of the use of electric motors in domiciliary industries. The particular industries investigated were the Swiss watch-making industry, the silk weaving at Lyons and the ribbon industry at St. Etienne, France. The authors visited these localities and got their information at first hand. Each industry is treated in detail, with an abundance of facts and figures; and the conclusion arrived at is that while the electric motor renders labor much more efficient. it is doubtful whether it can prevent the ultimate centralization of industries in factories.

Electric Railways.

Les Chemins de Fer Electriques. By Léon Gerard. Size 6 in. by 9½ in.; pp. 288; illustrations, 42. Paper covers.

This is one of the monthly bulletins of the Belgian Electrical Society, and contains a comprehensive and well-illustrated review of electric railways in their various aspects. There is a comparison between steam and electric traction, and the application of electricity to main line railways is discussed. Tables are given, in which electric railways are classified according to different systems, and in which comparative weights and other data are shown; and there is a bibliography.

Geometry.

The Foundations of Geometry. By David Hilbert, Ph. D. Translated by E. J. Townsend, Ph. D. Size, 5½ in. by 8 in.; pp. VII, 132; figures, 52. Price, $1.00 (4s. 6d.) Chicago: The Open Court Publishing Company. London: Kegan Paul, Trench, Trübner & Co., Ltd.

The material contained in this book was given in substance by Professor Hilbert as a course of lectures on Euclidean geometry at the University of Göttingen, where he occupies the chair of mathematics. He sets up a system of axioms, and then discusses their relations to one another, and also the bearing of each upon the logical development of Euclidean geometry. The translation into English is very intelligent and finished, and the book is thoroughly well made.

Graphics.

A Graphic Method for Solving Certain Questions in Arithmetic or Algebra. By George L. Vose. Size 3¾ in. by 6 in.; pp. 62; figures, 29. Price 50 cts. New York: D. Van Nostrand Company.

This is the second edition of one of the Van Nostrand science series, by the professor of civil engineering in Bowdoin College. The graphic method described was suggested by the common mode of representing the movements of railway trains, in which time is represented by the abscissas, distances by the ordinates, and train movements by diagonals whose inclination shows the speed. Prof. Vose applies this method to a variety of algebraic problems, which it solves very simply and quickly.

Labor and Capital.

Labor and Capital. A Discussion of the Relations of Employer and Employed. Edited by John P. Peters, D. D. Size, 5½ in. by 8 in.; pp. XLIV, 463. New York and London: G. P. Putnam's Sons.

This volume is one of the "Questions of the Day" series and contains the principal articles contributed to a symposium in the daily newspapers controlled by Mr. W. R. Hearst, the *American and Journal*, the *Chicago American* and *The Examiner*, of San Francisco. The general question discussed was: "Are the interests of employer and employed mutual, and, if so, how can this mutuality of interest be made effective?" Further, one or more special questions, on trusts, labor unions, arbitration, model industries, socialism, etc., were addressed to each contributor College professors, national and state officials, ecclesiastics, lawyers, philanthropists and reformers, men of affairs and labor leaders took part in this symposium, and

in most cases have revised their papers for the present volume, which altogether contains the broadest and most comprehensive discussion of the ever-present and all-important "labor-capital" question ever held.

Minerals.

A Classified List of Minerals, Precious and Other Stones. By Felix J. Troughton. Size, 4½ in. by 7½ in.; pp. 27. Price, 50 cents. New York: The Abbey Press.

This is an alphabetically arranged list of about 550 minerals and precious stones, with brief definitions.

Municipal Year Book.

The Municipal Year Book, 1902. Edited by M. N. Baker, Ph. B., C. E. Size, 6 in. by 9 in.; pp. LIV, 310. Price, $3.00. New York: The Engineering News Publishing Company.

This book, by the associate editor of "Engineering News," combines a directory of municipal officials and franchise companies, an exhibit of municipal and private ownership, and an outline of the leading public works and services in each of the 1,524 largest municipalities of the United States. It includes all the incorporated places of 3,000 population and upwards, by the U. S. Census of 1900, and, in addition, all New England "towns" of like size. The facts of most vital interest under each municipality are summarized and commented upon in the introduction, while the body of the book contains the detailed statistics of each place, such as population, assessed valuation, principal officials, ownership of public utilities, water supply, sewerage, street-cleaning, street sprinkling, garbage, fire department, electric wires. The towns are arranged alphabetically under their respective states and territories, which are grouped geographically. This work is a most useful one for everybody interested in municipal affairs, and forms as comprehensive a compilation of municipal statistics as probably ever has been made.

Polyphase.

Standard Polyphase Apparatus and Systems. By Maurice A. Oudin, M. S., Mem. Am. Inst. E. E. Size, 5¼ in. by 8 in.; pp. 289; figures, 169. Price, $3.00. New York: D. Van Nostrand Company. London: Sampson Low, Marston & Co.

This is the third edition of a work which was first published only three years ago, and which has now been brought up to date by describing the most recent applications of polyphase working. After a general introduction to alternating current theory, different classes of apparatus are described. Chapters are devoted to generators, induction motors, synchronous motors, rotary converters, static transformers, and station equipment and general apparatus, the last being particularly interesting, owing to the greatly increased demands upon modern controlling and switching devices. Then follow chapters on the two-phase, the three-phase and the monocyclic systems, the choice of frequency, the relative weights of copper for various systems, and the calculation of transmission lines, while an appendix contains the 1899 report of the Am. Inst. E. E. committee on standardization, to which, however, amendments have now been proposed. The book is well illustrated with many photo-reproductions of electrical apparatus, and has a number of diagrams and tables.

Railway Engineering.

Proceedings of the Third Annual Convention of the American Railway Engineering and Maintenance-of-Way Association, held at the Auditorium Hotel, Chicago, Illinois, March 18, 19 and 20, 1902. Size, 6 in. by 9 in.; pp. 501; figures, 9; plates, 11; paper covers.

The bulk of this volume is taken up with the proceedings of the association, consisting of papers, reports and discussions on various subjects relating to railway engineering, materials and accounts, and, in addition, the contents include past and present officers, list of members, deceased members, membership and mileage of roads represented in the association, standing committees and outline of committee work, committees of the board of direction, constitution and index.

Refrigeration.

Refrigeration, Cold Storage and Ice-Making. A Practical Treatise on the Art and Science of Refrigeration. By A. J. Wallis-Tayler, C. E., Assoc. M. Inst. C. E. Size, 5¾ in. by 8¾ in.; pp. XXI, 590; illustrations, 361. Price, $3.00. London: Crosby Lockwood and Son. New York: D. Van Nostrand Company.

This is a very comprehensive treatment of the subjects named in the title, well illustrated and made up into a handsome book. The various refrigerating processes and cold storage systems are fully described, there are chapters devoted to refrigerator cars and marine refrigeration, industrial and constructional applications, the management and testing of refrigerating machinery, the cost of working and the production of very low temperatures. An appendix contains useful tables and memoranda and a bibliography of refrigeration, while the work is completed by a full index.

Sanitary Science.

Principles of Sanitary Science and the Public Health, with Special Reference to the Causation and Prevention of Infectious Diseases. By William T. Sedgwick, Ph. D. Size, 6 in. by 9 in.; pp. XIX, 368. Plates, 6. Price, $3.00. New York: The

Macmillan Company. London: Macmillan & Co., Ltd.

The present volume is the outgrowth of a course of lectures given to the students of the Massachusetts Institute of Technology, where the author is professor of biology. It brings together and presents in a simple and logical form those fundamental scientific principles on which the great practical arts of modern sanitation securely rest. Different chapters are devoted to the human mechanism; diseases and their causes; the rise and influence of bacteriology; sanitary aspects of the struggle for existence; infection and contagion; various vehicles of infectious disease, such as sewage, water, ice, milk, uncooked foods; sewage disposal and purification; the establishment and conservation of purity in public water supplies; the prevention and inhibition of infection, decomposition and decay—asepsis and antisepsis; the destruction or removal of infection—disinfection and disinfectants. The principles laid down in this book are illustrated with an abundance of examples of actual occurrences, and the author has also drawn upon his own experience as biologist to the State Board of Health of Massachusetts, so that the work forms a very interesting and instructive presentation of a subject which is of the greatest and most general importance.

Surveying.

Plane Surveying. By Paul C. Nugent, A. M., C. E. Size, 6 in. by 9 in.; pp. XVI, 577; figures 320; plates, 6. Price, $3.50.

This is a text and reference book for the use of students in engineering and for engineers generally, by the associate professor of civil engineering in Syracuse University. It is a comprehensive treatise on surveying as practiced at the present time. It gives an account of linear measuring instruments and range poles; chain surveying; compass and general surveying: telescopes of surveying instruments; leveling; transit surveying; the planimeter and slide rule; topographical surveying; hydrographic surveying; mine surveying; the solar instrument; and United States public lands. Appendices treat of those modern developments in instrument construction and the theory and practice of surveying, the cyclotomic transit and phototopography. The book is copiously illustrated and enriched with many tables.

Water Flow.

Diagrams of Mean Velocity of Uniform Motion of Water in Open Channels; Based on the Formula of Ganguillet and Kutter. By Irving P. Church, C. E. Size, 12 in. by 9 in.; 11 diagrams. Paper covers. Price, $1.50. New York: John Wiley & Sons. London: Chapman and Hall, Limited.

It is perhaps quite generally admitted among hydraulic engineers that on account of the uncertainty usually attending the choice of a proper "coefficient of roughness" (n) in the use of Kutter's formula, it is well-nigh useless to observe great refinement in the employment of that well-known equation for the mean velocity of uniform motion of water in open channels. Suitable diagrams, therefore, can furnish solutions of this equation which answer every practical purpose. A collection of such diagrams, by the professor of applied mechanics and hydraulics in the College of Civil Engineering, Cornell University, is here presented, one for each of eleven different values of "n" (from .009 to .035), and ranging from 0.1 ft. to 25 ft. in the value of R, the hydraulic radius; the slope varying from 0.01 ft. per thousand to 100 ft. per thousand (that is, from $S = 0.00001$ to $S = 0.100$). Such being the range of application, covering all ordinary cases in practice, these diagrams constitute a fairly comprehensive "bird's-eye view" of Kutter's useful formula.

BOOKS ANNOUNCED.

Elementary Coal Mining. By George L. Kerr. Philadelphia: J. B. Lippincott Co.

Metallography: An Introduction to the Study of the Structure of Metals, Chiefly by the Aid of the Microscope. By Arthur H. Hiorns. Pp. XIV, 158; ill. $1.40. New York: The Macmillan Company.

Metallurgy of Cast Iron: A Complete Exposition of the Processes Involved in its Treatment, Chemically and Physically, from the Blast Furnace Through the Foundry to the Testing Machine: A Practical Compilation of Original Research. 5th ed. By Thomas D. West. Pp. XX, 627; ill. and diagrams. $3. Cleveland: Cleveland Printing and Publishing Co.

How to Become a Competent Motorman; A Practical Treatise on the Proper Method of Operating a Street Railway Motor Car, also Giving Details on How to Overcome Certain Defects. By Virgil B. Livermore and James Williams. Pp. 232; ill. and diagrams. $1. Brooklyn: Wm. S. Livermore.

Cramp's Shipyard, 1830-1902. Published for private circulation by William Cramp & Son, Philadelphia.

Submarine Warfare, Past, Present and Future. By Henry C. Fyfe. New York: P. Dutton & Co.

Manual of Land Surveying. New edition. By F. Hodgman, M. S., C. E. Pp. 525; ill.; price, $2.50. Climax, Mich.: F. Hodgman.

La Convention du Mêtre et le Bureau International des Poids et Mesures. By Ch. Ed. Guillaume, Associate Director of the International Bureau of Weights and Measures. 4to.; ill.; price, 7 fr., 50c. ($2.25); Paris: Librarie Gauthier-Villars.

NEWS SUPPLEMENT

The Engineering Magazine—October, 1902

Coming Society Meetings.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. Sec.: Prof. L. O. Howard, Cosmos Club, Washington, D. C. Annual meeting, Dec. 29 to Jan. 3, Washington.

AMERICAN GAS LIGHT ASSOCIATION. Sec.: A. E. Forstall, 58 William street, New York. Annual convention, Oct. 15, New York.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Regular meetings on fourth Friday of each month, 12 W. 31st St., New York. Oct. 24, paper by Prof. Chas. P. Matthews: "An Integrating Photometer for Glow Lamps and Sources of Like Intensity."

AMERICAN INSTITUTE OF MINING ENGINEERS. Sec.: R. W. Raymond, 99 John St., New York. 83rd meeting, Oct. 14, etc., New Haven, Conn.

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York. Meeting Oct. 22, Detroit.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION. Sec.: L. C. Fritch, Cincinnati. Annual meeting, March, 1903.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month. Oct. 1, paper by Theron A. Noble, on "The Flow of Water in Wood Pipes;" Oct. 15, paper by R. G. Allanson-Winn, on "The Protection and Improvement of Foreshores by the Utilization of Tidal and Wave Action." Annual meeting, Jan. 21 and 22, 1903.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Semi-annual meeting Dec. 2-5.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. Sec.: Geo. W. Tillson, Municipal Building, Brooklyn, N. Y. Annual meeting, Oct. 7, 8 and 9, Rochester, N. Y.

AMERICAN SOCIETY OF RAILROAD SUPERINTENDENTS. Sec.: C. A. Hammond, Mt. Vernon, N. Y. Annual meeting, Oct. 2.

AMERICAN STREET RAILWAY ASSOCIATION. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Oct. 8, 9 and 10, Detroit.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS. Sec.: S. F. Patterson, Concord, N. H. Annual convention, Oct. 21, 22 and 23, Minneapolis, Minn.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except January, when on fourth Wednesday.

CANADIAN RAILWAY CLUB. Sec.: M. P. Kelly, Montreal. Regular meetings on second Tuesday of each month.

CANADIAN ROADMASTERS' ASSOCIATION. Sec.: J. Drinkwater, Winchester, Ont. Meeting Oct. 9.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Regular meetings, Oct. 9, 23; Nov. 6, 20. Annual meeting, Jan. 8.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Nov., Jan., March, May, Sept., Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. J. Warder, Jr., 900 Warren Ave. Regular meetings on first Friday of each month.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Arthur A. Skeels, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: H. M. Jones, 1000 Broad St., Nashville, Tenn. Regular meetings on second Thursday of each month, at Vanderbilt University.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meetings on third Thursday of each month.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 12½ North High St. Regular meetings on first and third Saturdays of each month.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Edw. P. Burch, 1210 Guaranty Bldg. Regular meetings on third Monday of each month.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: L. F. Rondinella, 1122 Girard St. Regular meetings on first and third Saturdays of each month.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: D. W. Roper, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: George T. Roberts, 975 Ellicott Square, Buffalo. Regular meetings, first Tuesday of each month.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month. Regular monthly meetings of the various sections on other days.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Sec.: Frank P. Foster, Corning, N. Y. Meeting, Oct. 7, 8 and 9, Richmond, Va.

IOWA RAILROAD CLUB. Sec.: J. A. Wagner, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 712 Union St., New Orleans. Regular meetings on the second Monday of each month.

MONTANA SOCIETY OF ENGINEERS. Sec.: Richard R. Vail, Butte, Mont. Regular meetings on second Saturday of each month.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: James B. Cahoon, 136 Liberty St., New York. Meeting, May, 1903, Chicago.

NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION. Sec.: C. J. H. Woodbury, Boston. 73rd meeting Sept. 30 to Oct. 2, at 12 W. 31st St., New York.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings second Tuesday in each month at Pierce Hall, Copley Square.

NEW YORK RAILROAD CLUB. Sec.: W. B. Yereance, 168 Montague St., Brooklyn. Regular meetings on third Thursday of each month at 349 Madison Ave., New York. Oct. 16, paper by R. L. Calkins, on "The Work of the Claim Department."

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, alternating between Minneapolis and St. Paul.

OHIO ELECTRIC LIGHT ASSOCIATION. Sec.: J. H. Perkins, Youngstown, O. Meeting, Oct. 14, 15 and 16, Columbus, O.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Barton, West Oakland, Cal. Regular meetings on third Saturday of each month, at San Francisco.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month at Hotel Henry.

RAILWAY SIGNALING CLUB. Sec.: C. O. Tilton, West Milwaukee, Wis. Annual meeting, Nov. 11, Pittsburg.

RICHMOND RAILROAD CLUB. Sec.: F. O. Robinson, C. & O. R. R., Richmond, Va. Regular meetings on second Thursday of each month.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: K. E. Steinhauer, 1065 Clarkson St., Denver. Regular meetings on first Saturday after the 15th of each month.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS. Sec.: W. L. Capps, 12 W. 31st St., New York. Annual meeting, Nov. 20 and 21, 12 W. 31st St., New York.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov.

TECHNICAL SOCIETY F THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

WESTERN RAILWAY CLUB. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, 1737 Monadnock Block, Chicago. Regular meetings: Oct. 1, paper by J. N. Hatch on "Modern Handling of Iron Ore on the Great Lakes;" Nov. 5, paper by Elwood Read on "Irrigation." Extra meetings on third Wednesdays of each month.

Personal.

—Mr. Andrew Carnegie was elected president of the Iron and Steel Institute at the annual meeting held in Düsseldorf.

—Mr. Alexander C. Humphreys, who was elected to the presidency of Stevens Institute in the early summer, has returned from Europe and has entered upon the active discharge of the duties of his new office.

Colonel Yorke, the chief inspecting officer of the railway department of the British Board of Trade, will make a short trip this fall to the United States, for the purpose of investigating railroad affairs in this country.

—J. Yamaguchi, of Kobe, Japan, Chief Engineer of the Sanyo Railroad, who has been studying the railway systems of Europe and America, is on his way home.

—Mr. George G. Earl has been re-elected general superintendent of the New Orleans Sewerage and Water Board.

Prof. H. Haber, of the Carlsruhe Technical High School, in Baden, and who is a member of the German Bunsen Society, was an official delegate to the recent convention of the American Electrochemical Society, at Niagara Falls. While in this country he will also make a study of the American electro-chemical industry.

—Count von Thille-Winckler, a prominent German financier and mine owner, will probably visit the United States this fall, in order to make a study of our large manufacturing industries, particularly those in iron and steel.

Mr. Paul Schueler, of Magdeburg, a railway engineer in the service of the German Government, is on a visit to the United States, in order to investigate methods of railway transportation, both steam and electrical.

—Mr. Albert Ladd Colby, of the Bethlehem Steel Co., is in Europe, making some special investigations for his company.

—William E. Dickey, late P. Asst. Engr. U. S. N., announces that on and after August 25th, 1902, he will represent The Goulds Mfg. Co., Seneca Falls, N. Y., and The West Point Boiler Works (R. Munroe & Son), Pittsburg, Pa., at 16 Murray street, New York.

—Mr. Newton Bell, the San Francisco representative of the Trenton Iron Co., has recently died. His successor has not yet been appointed.

—Mr. George W. Scott, the consulting engineer, of Chicago, has charge of the extensive improvements and additions which Parke, Davis & Co., of Detroit, the well-known manufacturers of drugs and chemicals, are making to their electrical, steam and power plant.

—Mr. A. R. Sheppard, of Chicago, has recently assumed the position of secretary and treasurer of the Edmonds-Metzel Manufacturing Co., of that city.

Industrial Notes.

—The contract for the entire mechanical and electrical equipment for the new plant at Philadelphia of the Crompton & Knowles Loom Works of Worcester has been placed with Sargent, Conant & Co. of Boston. Power for the entire works will be transmitted and distributed electrically.

—It is reported that by the use of the new Spitzkasten or Hydraulic Classifier recently gotten out by The Denver Engineering Works Company the Gregory Bobtail Mill at Black Hawk has increased the savings of values from the ore from 55% to 90%. The bulletin describing this new apparatus is ready for distribution.

—Mr. A. Tait, assistant manager of the works of Messrs. George Angus & Co., Ltd., Newcastle-on-Tyne, England, one of the largest leather manufacturers of the United Kingdom, recently spent two weeks in Syracuse, N. Y., having come to this country especially to visit the works of the New Process Raw Hide Co. An arrangement was made with Messrs. Angus & Co. by T. W. Meachem, president of the rawhide company, during a recent trip abroad, whereby the English concern is to establish a plant in England for the manufacture of rawhide gears and other products under the patents and secret processes of the New Process Raw Hide Co. and using the latter company's trade mark. This plant it is expected will take care of the company's business not only in Great Britain but throughout Europe, Messrs. Angus & Co. having offices in nearly all of the principal cities and therefore being excellently situated to care for this trade. Upon Mr. Tait's return to England he will place orders with American firms for the latest gear-making machinery, and will proceed at once with the fitting out of the new factory, which will also be located at Newcastle-on-Tyne. Messrs. Angus & Co. have been the agents of the New Process Raw Hide Co. in Great Britain for eight years and have a well-established trade in New Process Noiseless Pinions.

—An electric trolley line has recently been built in the city of Bello Horizonte, the capital of the State of Minas Geraes, Brazil. The track is laid on steel ties, is 12 kilometres long and runs through the principal thoroughfares of the city, and is designed as the main or trunk line of a system of passenger transportation which will in future embrace the entire city. The electric cars are elegant, perfectly lighted, furnished with all improvements, such as headlights, bells and fare registers, and are built of the best kind of wood by the St. Louis Car Manufacturing Co. They have a capacity of

32 passengers, and are mounted on Peckham trucks. Each car will have two motors of 37 H. P., and electric brakes and switches which will assure perfect safety when ascending or descending the grades, some of which are as high as ten per cent. The supply of the materials and the installation of the electric line was entrusted to the well known Brazilian engineers and contractors, Messrs. Julio V. Brandao & Co., of Rio de Janeiro, who will be pleased to hear from American contractors and manufacturers concerning the selling of machinery and the building and equipment of engineering works.

—The Lane & Bodley Co., of Cincinnati, are planning a foundry, primarily for their own Corliss engine business, and secondarily for a jobbing foundry. The foundry will be 120 feet wide and of indefinite length. The land owned will admit of its extension for about one thousand feet. If there is anything profitable to be installed in a new foundry for their own standard work or for jobbing, they want to carefully consider it, and if any provision should be made in the foundry arrangement or construction to adapt it to such profitable apparatus or appliances, they want to know it before and not after the building is constructed. Blue prints indicating the proposed arrangements will be furnished to inquirers, and any suggestions for improvements will be gladly received by the Lane & Bodley Co.

—The annual report of Admiral Melville of the United States Navy, shows that the Foster Engineering Company of Newark, N. J., furnished the United States government with automatic valves, reducing and regulating valves, to the aggregate weight of 17,683 lbs. during the year 1901.

—The Alberger Condenser Company of 95 Liberty street, New York, has recently entered into a large contract with the Commonwealth Electric Company of Chicago for a complete condensing plant, to be installed in that company's new power house at Chicago. This plant will include one of the largest surface condensers ever furnished for use on land. It is of the Alberger high vacuum type and will have 20,000 square feet of cooling surface. The pumping plant used in connection with this condenser consists of an Alberger dry vacuum pump with Corliss valves; a centrifugal circulating pump; a hot well with pump driven by Corliss engine, a heater of 2,000 square feet; and two vertical boiler feed pumps. The entire equipment represents the most advanced form of condensing engineering, and a vacuum of 28 inches is required to be maintained. This condensing plant will operate in connection with a 7,500-horse-power turbine generator which is to be installed.

—The United Fruit Co., of 21 State street, New York, has placed a contract with the American Supply & Construction Co., Engineers, 120 Liberty street, New York, covering three engines, tandem compound condensing, three water-tube boilers, condensers, heaters, pumps, separators, piping, belts, etc. This machinery will be used to furnish power for an electric light and power plant on the United Fruit Co.'s banana plantation in Costa Rica, Central America.

—American electrical apparatus is making remarkable progress in European markets. The Société Anonyme Westinghouse has found it necessary, on account of the great number of orders, to make extensive additions to its plant, which has been in operation for only five years. This plant is located at Havre, France, and supplies the territory included in Holland, Belgium, Italy, Switzerland, Spain, France and their colonies and protectorates.

—The New York Continental Jewell Filtration Co., of 15 Broad street, New York city, report an active business in filters for water works, manufacturing business, etc. They have just completed the erection of a filter plant for the new building of the New York Stock Exchange, New York City; also filter plants for the St. Andrews Academy, Poughkeepsie, N. Y., and the Beaver Valley Water Co., Beaver Falls, Pa., and have just received a contract for the new Y. M. C. A. building, West 23rd street, between 7th and 8th avenues, New York.

—The Denver Engineering Works Company have recently shipped complete a 10-stamp mill, including a complete saw mill plant, to R. B. Pratt, Thomasville, Colorado. In this mill will be used one of the new and wonderful hydraulic classifiers recently developed by The Denver Engineering Works Company from experiments and data obtained by Professor Richards on this subject. They have also commenced the

shipment of the material for a 40-stamp mill for The Penobscot Mining Company of Deadwood, South Dakota.

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—The Massachusetts Fan Co. have discontinued their Boston office, and all mail should be addressed to the factory, Waltham, Mass. Express matter should be sent to Waltham via American, National or Gibbs Express Companies. Goods shipped by water via Boston should be marked "Massachusetts Fan Co., Waltham, Mass., care Gibbs Express Co., Boston." All rail shipments should reach them by the Fitchburg division of the Boston & Maine R. R.

—The Pittsburgh Gage & Supply Co., Pittsburgh, are furnishing two 125-H. P. boilers to the Cadiz Electric Light & Power Co., Cadiz, O., and a complete oil filtering system for the Sleepy Eye Milling Co., Sleepy Eye, Minn. The Pittsburgh Gage & Supply Co. have issued a catalogue of some 686 pages, which is a complete exposition of illustrations, descriptions, and price lists of general machinery and supplies.

—It will be of interest to engineers and to users of gearing generally to know that the H. W. Caldwell & Son Company, of Chicago, Ill., have recently purchased the entire equipment of gear patterns, molding machinery, gear cutters and all other appliances pertaining to the power transmission business of the Walker Mfg. Co., of Cleveland, O. The Walker gears have for many years sustained a reputation for excellence and correctness of design, and the Walker system is generally recognized as founded upon correct principles. The general satisfaction that these gears have given to users, as evidenced by many testimonials and the fact that they are preferred by many mechanical engineers, has established for these gears an enviable reputation. The Walker pattern list is probably the most complete in existence, and from its wide variety it is possible to find almost anything to meet the requirements of any situation where gears are to be used. The Caldwell Company state that they are prepared to furnish gears from the Walker patterns promptly, and that they will maintain the high standard established for these gears by the Walker Company.

32 passengers, and are mounted on Peckham trucks. Each car will have two motors of 37 H. P., and electric brakes and switches which will assure perfect safety when ascending or descending the grades, some of which are as high as ten per cent. The supply of the materials and the installation of the electric line was entrusted to the well known Brazilian engineers and contractors, Messrs. Julio V. Brandao & Co., of Rio de Janeiro, who will be pleased to hear from American contractors and manufacturers concerning the selling of machinery and the building and equipment of engineering works.

—The Lane & Bodley Co., of Cincinnati, are planning a foundry, primarily for their own Corliss engine business, and secondarily for a jobbing foundry. The foundry will be 120 feet wide and of indefinite length. The land owned will admit of its extension for about one thousand feet. If there is anything profitable to be installed in a new foundry for their own standard work or for jobbing, they want to carefully consider it, and if any provision should be made in the foundry arrangement or construction to adapt it to such profitable apparatus or appliances, they want to know it before and not after the building is constructed. Blue prints indicating the proposed arrangements will be furnished to inquirers, and any suggestions for improvements will be gladly received by the Lane & Bodley Co.

—The annual report of Admiral Melville of the United States Navy, shows that the Foster Engineering Company of Newark, N. J., furnished the United States government with automatic valves, reducing and regulating valves, to the aggregate weight of 17,683 lbs. during the year 1901.

—The Alberger Condenser Company of 95 Liberty street, New York, has recently entered into a large contract with the Commonwealth Electric Company of Chicago for a complete condensing plant, to be installed in that company's new power house at Chicago. This plant will include one of the largest surface condensers ever furnished for use on land. It is of the Alberger high vacuum type and will have 20,000 square feet of cooling surface. The pumping plant used in connection with this condenser consists of an Alberger dry vacuum pump with Corliss valves; a centrifugal circulating pump; a hot well with pump driven by Corliss engine, a heater of 2,000 square feet; and two vertical boiler feed pumps. The entire equipment represents the most advanced form of condensing engineering, and a vacuum of 28 inches is required to be maintained. This condensing plant will operate in connection with a 7,500-horse-power turbine generator which is to be installed.

—The United Fruit Co., of 21 State street, New York, has placed a contract with the American Supply & Construction Co., Engineers, 120 Liberty street, New York, covering three engines, tandem compound condensing, three water-tube boilers, condensers, heaters, pumps, separators, piping, belts, etc. This machinery will be used to furnish power for an electric light and power plant on the United Fruit Co.'s banana plantation in Costa Rica, Central America.

—American electrical apparatus is making remarkable progress in European markets. The Société Anonyme Westinghouse has found it necessary, on account of the great number of orders, to make extensive additions to its plant, which has been in operation for only five years. This plant is located at Havre, France, and supplies the territory included in Holland, Belgium, Italy, Switzerland, Spain, France and their colonies and protectorates.

—The New York Continental Jewell Filtration Co., of 15 Broad street, New York city, report an active business in filters for water works, manufacturing business, etc. They have just completed the erection of a filter plant for the new building of the New York Stock Exchange, New York City; also filter plants for the St. Andrews Academy, Poughkeepsie, N. Y., and the Beaver Valley Water Co., Beaver Falls, Pa., and have just received a contract for the new Y. M. C. A. building, West 23rd street, between 7th and 8th avenues, New York.

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NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Acetylene.

Folders, devoted to the Colt carbide-feed acetylene gas generators, "Colt-Napheys" and Von Schwarz "Perfection" acetylene gas burners, and acetylene stoves and radiators. J. B. Colt Co., 21 Barclay street, New York.

Acetylene Burners.

Neat booklet, with illustrated descriptions and price lists of acetylene gas burners. Sunlight Lave Mfg. Co., Chattanooga, Tenn.

Air Compressor.

Illustrated pamphlet, printed in Danish, describing the American air lift pumping system, and a few types of the American air compressors and governors. It also contains a cut and descriptive list of the direct-acting air compressor manufactured by the Union Steam Pump Co. American Air Compressor Works, New York.

Belting.

Handsomely illustrated catalogue, with descriptions and price lists of oak-tanned leather belting for all purposes, belt lacing, belt dressing, cement and oil, and various auxiliaries, views of plants, tables and telegraph code. Also booklets devoted to "leatherine," a belt filler and preservative, and cards devoted to various styles of belting. Chas. A. Schieren & Co., New York.

Blowers.

Handsome, illustrated sectional catalogue No. 141, devoted to "A B C" pressure and volume blowers and auxiliary apparatus, with tables of useful data. Also booklet with views of the manufacturing plant. American Blower Co., Detroit.

Cable Railways.

Catalogue No. 029, tastefully made and with handsomely-illustrated descriptions of Hunt cable railways for handling coal and merchandise, and views showing many of these railways in operation. C. W. Hunt Co., West New Brighton, New York.

Calculagraph.

A well-illustrated pamphlet showing how the calculagraph may be used for cost-keeping in factories and for other purposes. Also, price list and booklets describing various uses of this time-calculating machine. The Calculagraph Co., New York.

Card Systems.

A handsomely-illustrated pamphlet of the "Shaw-Walker" card system as applied to indexing, cost-keeping, bookkeeping, and a great variety of other purposes. The Shaw-Walker Co., Muskegon, Mich.

Concrete Mixers.

Catalogue No. 5, with handsomely-illustrated descriptions of apparatus for mixing and laying concrete, and of engineering works where it is being used. Kaltenbach & Griess, Engineers, Cleveland.

Counters.

Booklet devoted to the Durant counter for counting revolutions and strokes of all kinds of machines, with list of recent sales. W. N. Durant, 231 Twenty-second street, Milwaukee.

Electric Apparatus.

Bulletins Nos. 1025, 1030 and 1032, devoted respectively to direct-current belted generators, single-phase generators and direct-current belted motors, with well-illustrated descriptions. Also flyers Nos. 4025 and 4037, showing the "Wood" cut-out for arc circuits, and an oil transformer struck by lightning and uninjured. Fort Wayne Electric Works, Fort Wayne, Ind.

Electric Hoists.

Buletin No. 1015, with well-illustrated descriptions of different kinds of electric hoists, particularly for mining purposes. A great range of sizes is manufactured, and there is a general drawing of each hoist, accompanied by a table giving all dimensions necessary for its location. The Denver Engineering Works Co. (Shepard and Searing), Denver, Colo.

Electric Machines.

Bulletins Nos. 1002, 1003, 1012 and 1013,

devoted to direct-current multipolar electric motors, marine lighting and power sets, and direct-current multipolar generators, with well-illustrated descriptions and telegraph code. Bullock Electric Mfg. Co., Cincinnati.

Electric Motors.

Bulletin No. 29, with well-illustrated descriptions of various styles of electric motors, including a special vertical type, and of their applications in driving many kinds of machines. Northern Electrical Mfg. Co., Madison, Wis.

Feed-Water Purifiers.

Tasteful booklets with illustrated descriptions of the Sorge-Cochrane system for the thorough heating and purification of water for boiler feed and other purposes. Harrison Safety Boiler Works, Philadelphia.

Filing Correspondence.

Booklet devoted to the Rockwell-Wabash system of filing correspondence, with illustrations of vertical filing cabinets. Rockwell & Rupel Co., Chicago.

Fire Extinguisher.

Booklet devoted to the Manville fire extinguisher, a dry powder compound, put up in metal tubes, and always ready for instant use, with account of test, testimonials and list of users. H. W. Johns-Manville Co., New York.

Fire Hose.

Attractive pamphlet, well illustrated, devoted to fire hose and its manufacture. Also tasteful catalogue and price list of fire hose and other styles of hose and all kinds of fire supplies. Eureka Fire Hose Co., New York.

Gas Stoves.

Pamphlets, with illustrated descriptions of odorless gas stoves in various styles, both blue-flame and white-flame, for heating and cooking. Stamford Gas Stove Co., Stamford, Conn.

Industrial Railways.

Bulletin No. 0216, with description and many illustrations of the Hunt system of industrial railways and cars, as installed in various works. C. W. Hunt Co., West New Brighton, New York.

Injectors.

Pamphlet, with very well illustrated descriptions and price lists of Metropolitan automatic, "1898" and double-tube injectors, H-D ejectors, H-D noiseless water heaters, strainers and funnels, and Hancock "swing" check valves, globe and angle valves. The Hayden & Derby Manufacturing Co., New York.

Insulators.

Catalogue No. 6, with well-illustrated descriptions of "Victor" porcelain and glass insulators for high-voltage electric lines; steel and wood pins; cross-arms and brackets; and list of plants using these insulators and pins. Fred M. Locke, Victor, N. Y.

Link-Belt.

Pamphlet, with very good illustrations and descriptions of applications of link-belt conveying machinery to locomotive coaling stations, and freight carriers for loading and unloading vessels; and of link-belt adjustable chutes. The Link-Belt Engineering Co., Nicetown, Philadelphia.

Locomotives.

Record of Recent Construction, No. 36, with handsome illustrations and descriptions, in French and English, of various types of locomotives. Baldwin Locomotive Works, Philadelphia.

Locomotive Stoker.

Tasteful pamphlet, with well-illustrated descriptions of the Kincaid locomotive stoker for mechanically firing locomotive boilers. The Day-Kincaid Stoker Co., Cincinnati.

Lubricators.

Neat booklet, with illustrated description and price list of Sterling force-feed lubricators. Sterling Lubricator Co., Rochester, N. Y.

Machine Tools.

Tasteful catalogue with illustrated descriptions of horizontal boring, milling, and drilling machines; cold saw cutting-off machines; plain milling machines; and automatic saw-sharpening machines. The Franklin Machine Works, Incorporated, Philadelphia.

Mechanical Stokers.

Large pamphlet, with well-illustrated descriptions of the improved Acme smokeless mechanical stoker and hand-fired furnace. Ross & Co., 95 and 97 Liberty St., N. Y.

Folder devoted to the successful installation of Jones under-feed mechanical stokers in the power plant of the University of Chicago. The Under-Feed Stoker Co. of America, Chicago.

Oil Burners.

Folders and card devoted to the Hammel burner for fuel oil, giving directions applying and operating it, results of tests and partial list of users. Hammel Oil Burner Co., Los Angeles, Calif.

Perforated Metals.

Pamphlet, with illustrations and descriptions of perforated metals of all kinds and with various styles of perforations. The Robert Aitschison Perforated Metal Co., Chicago.

Pneumatic Tools.

Tasteful pamphet, with well-illustrated descriptions of pneumatic tools, hoists and motors, and of their operation. Port Huron Air Tool Co., (Limited), Port Huron, Mich.

Rock Drills.

Catalogue No. 15, containing well-illustrated descriptions of the Jackson hand-power rock drill and equipment, with price list and testimonials. H. D. Crippen, 52 Broadway, New York.

Spitzkasten.

Bulletin No. 1016, containing a well illustrated description of the "spitzkasten" for the hydraulic classification of ore pulps. General dimensions and shipping weights are given, and there are tables showing the maximum size of particles passing through screens of different meshes, together with other useful data. The Denver Engineering Works Co. (Shepard and Searing), Denver, Colo.

Steam Turbines.

Bulletin No. 1, giving a complete report of a test, made by Messrs. Dean and Main, of a 300-H. P. De Laval steam turbine, driving dynamos at the De Laval factory in Trenton, N. J. De Laval Steam Turbine Co., New York.

Steel Forgings.

Neat booklet with a short story of Sir Henry Bessemer and his inventions, and some account of duplicate steel forgings. Wyman & Gordon, Worcester, Mass.

Surveying Instrument.

A folder, illustrating and describing the "Common Sense" transit and level, a simple and inexpensive instrument for approximate leveling. Jackson Co., Denver, Col.

Telephone Switchboards.

Tasteful pamphlet, with handsomely-illustrated descriptions of the "unit-type" telephone switchboards, consisting of single sections, uniform in style, and so designed that they can be placed side by side, making a continuous frame; also, descriptions of all kinds of telephone apparatus. The North Electric Co., Cleveland.

Valves.

Revised catalogue and price list of 208 pages, with illustrations and descriptions of brass and iron valves, injectors, whistles, lubricators, oil and grease cups and steam specialties. The Lunkenheimer Co., Cincinnati.

Water Elevators.

Special price list, No. 62 A, a tasteful, illustrated pamphlet devoted to Jeffrey water elevators, which are designed particularly for irrigating and drainage purposes. The Jeffrey Manufacturing Co., Columbus, Ohio.

Water Wheels.

Book of 78 pages, with well-illustrated descriptions of Cassel self-governing water wheels, in which instantaneous and close regulation is secured by automatically moving the double buckets apart. Also a discussion of water power in general, and useful tables. The Cassel Automatic Water Motor Co., Seattle, Wash.

Wire Rope Transmission.

A well-illustrated pamphlet, giving a description of the usual methods of the transmission of power by wire rope, with practical rules for general work. Views are shown of various plants in operation, and there are descriptions of wire rope, sheaves, sheave linings and other auxiliaries. John A. Roebling's Sons Co., Trenton, N. J.

Wood Pavement.

An illustrated pamphlet devoted to creoresinate wood pavements, giving accounts of experience with it in various cities and opinions of users. United States Wood Preserving Co., New York.

IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Calculagraph.

THE calculagraph is an instrument which makes a mechanical calculation of elapsed time or of the monetary value of elapsed time, and furnishes a printed record of the result.

The elapsed time record may be made in minutes and fractions of a minute, in which form it is peculiarly adapted to telephone service, in recording the time of conversations; or it may be made in hours and minutes. In the latter form it is especially suitable for manufacturing plants and in every place where labor is employed.

The dollar-and-cent instrument, or that form of the calculagraph which computes the value of elapsed time and prints the result in dollars and cents, can be geared to calculate at any rate per hour from ten cents to two dollars. It may be used to produce vouchers for the pay roll of workmen who are paid for the number of hours employed, at some uniform rate per hour, and is also extremely useful for messenger service, in billiard rooms, in the livery business, etc.

THE CALCULAGRAPH.

The calculagraph will also print the time of day when a record begins or ends, in addition to the result of the calculation above described. The operator may in this way print the time of day a workman commenced and the time he finished work, as well as the amount of his earnings, and thus the employer will be supplied with data to settle all disputes which may arise as to the accuracy of the latter record.

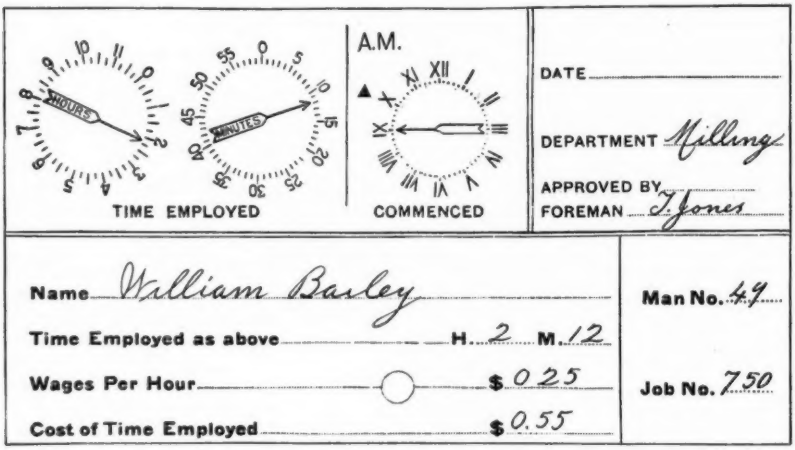
The printing mechanism is operated by means of two levers at the top and requires no special skill. Any person competent to insert a ticket in the slot and pull the levers may work it. The operation is entirely noiseless, and is accompanied by no pounding or jarring of the mechanism. The number of separate calculations and records which may be made on a single instrument is limited only by the number of times it is possible to insert tickets in the slot and pull the levers. The completion of the record is correctly made on each ticket without reference to the order in which the records were commenced.

A manufacturing plant provided with a calculagraph in each department, is equipped for gathering data which, with the least amount of clerical work in tabulating, will show the exact labor cost of every item of its varied product. A typical record is shown in the accompanying illustration. This card is marked by the calculagraph when the workman begins his part of the job, and again marked when he finishes. The resulting record shows the number of hours and minutes he expended upon this job, and also the time of day he commenced. Each operative who in his turn takes up the same job will receive a similar card, and if

he is employed more than one day upon it, there may be several cards bearing his name or number. All cards relating to this job are collected together and thus form a reliable and permanent record of the total labor cost.

The calculagraph may be employed in like manner to keep tab on piece workers, and will furnish accurate data for fixing the rate of pay. It may be used, in the absence of other apparatus for that purpose, to record the arrival and departure of all employees, but its great value is found in the keeping of labor costs. Wherever elapsed time has a value, it will repay its cost in a very short time by the saving of clerical work and in the elimination of errors.

The calculagraph is constructed of the best materials and is substantial and durable. It is furnished in several forms: In a portable case, as shown in the accompanying illustration; or fitted with a flange and adapted to be supported in an opening in a counter or bench or table, with its top flush with the top of the table; or mounted upon a pedestal, adjustable in height, with a base which can be screwed to the floor. Any further information desired will be gladly furnished by the Calculagraph Company, 9-11-13 Maiden Lane, New York.



CALCULAGRAPH TIME COST CARD.

Universal Milling Machines.

THE Becker-Brainard Milling Machine Co., of Hyde Park, Mass., have placed upon the market a new line of plain and universal milling machines from new designs and patterns. These machines embody many new features, special attention being given to strength, power and rigidity in order to meet the demands of modern milling machine practice.

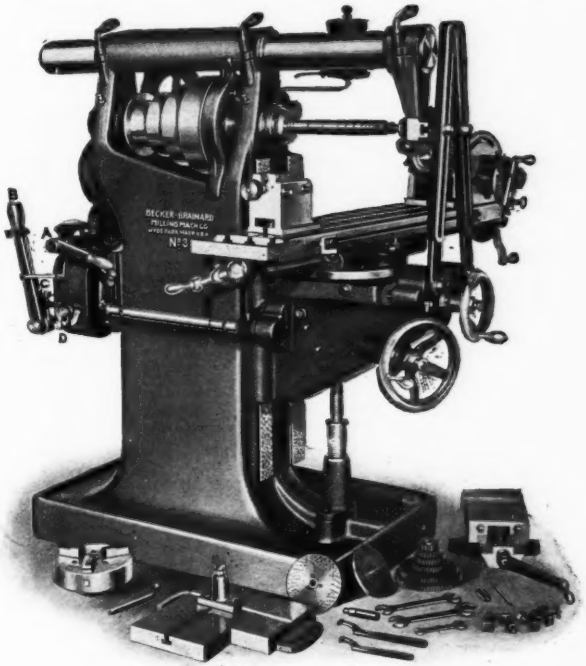
In the universal machines, the spindle is connected with the change feed mechanism by a train of three spur gears, thereby eliminating the usual feed pulleys and belt, giving positive gear drive necessary for heavy and rapid cuts.

The change feed mechanism is a novel feature and obviates the loss of time in changing gears as was formerly the practice in old style machines. The feed is obtained and driven by the main spindle through a train of three spur gears on the back of the machine which drive two nests of change feed gears in the column. By compounding the gears in the upper nest, the various changes of speed are secured, giving, with the quick change in the gear case on the outside of the machine, twenty changes of feed for each spindle speed. Levers, operating the change feed mechanism, are conveni-

ently located on the side of the feed box, and all changes may be made by the operator without stopping the machine or changing his position. The changes are made by the simple movement of the levers bringing them into position indicated on the index plate which has each feed plainly marked on its surface, showing the exact position to which the levers must be brought to give a desired feed per revolution of the spindle. For example, suppose a feed at the rate of seventeen thousandths per revolution of the cutter is to be obtained, the lever (B), as shown by the cut, is placed in the notch marked (3) on the lower quadrant (C) and then the lever (A) is brought to the line marked (3) opposite the space .017 on the index plate, the quick change lever (D) on the lower side of the feed box is then moved to the hole marked slow and the desired feed is obtained. Should it be desired to increase the speed, simply move lever (A) so as to point to the line at 3 prime and .019 is obtained; if the feed is to be decreased move the lever (B) to notch four on quadrant (C) and .013 is obtained.

When the fast feeds are desired, the quick change lever (D) is thrown into the hole marked "fast" and the same operation performed as described above.

The power is transmitted from the change feed mechanism through the telescopic shaft connecting, by gears, the longitudinal, transverse, and vertical feeds, which are reversed by a lever on the side of the knee within easy reach of the operator. Both transverse and vertical feeds are operated and controlled by a lever, located on the side of the knee, which, when central, disconnects both feeds, and when thrown into position for one feed makes it impossible to connect the other.



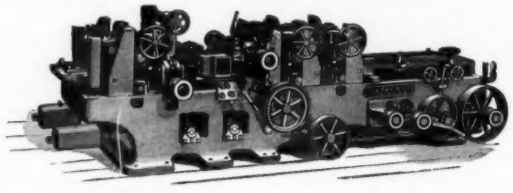
BECKER-BRAINARD MILLING MACHINE.

Another important feature is a clutch arrangement enclosed in the hubs of the hand wheels which operate the vertical movement of the knee and cross movement of the carriage. When either the knee or carriage

has been set to the required position, the clutch may be instantly disengaged by pressing in the knob on the front of the hand wheel, thereby preventing any accidental change from their fixed position, and also preventing the wheels from revolving when the automatic feeds are thrown in.

The knee, which is of box type, provided with a telescopic elevating screw, makes holes in the floor unnecessary and allows the machine to be placed regardless of beams or foundations. The thrust of the screw is taken by ball bearings.

In designing these machines the greatest care has been taken to secure the highest efficiency, together with accuracy and simplicity. Nevertheless, the parts are so arranged that they are within easy reach of the operator and of sufficient strength to prevent breakage from undue strain. Metal distribution has been properly proportioned, the base being very solid, thereby absorbing vibration. The arm is a straight steel bar, so that any of the regular attachments can be placed in a position without the necessity of removing the arm. The Becker-Brainard Milling Machine Co. will be glad to supply any further information desired.



New Triple-Cylinder Floorer.

THE attention of our readers is invited to this new and improved flooring machine, as in certain work a flooring machine is indispensable. This class of machinery has been a very successful line with the makers, and they without hesitancy claim this as one of their best and newest. It was patented March 20th, 1900, and is designed for those who make flooring, ceiling, siding, casing, etc., in large quantities. Consideration of some of its points will prove interesting.

1. It planes four sides 9 and 14 inches wide and 6 inches thick, and by the use of an endless-belt apparatus, 1½ inch stock can be matched to advantage. This last device is a new feature. The massive frame prevents vibration, resists all strain, and the machine can be run at a very high rate of speed if desired and under the absolute control of the operator.

2. The feed is six large powerfully-driven rolls, having expansive gearing, and which can be easily raised and lowered. The feeding-out one is provided with scrapers, and the rate of feed can be furnished as desired.

3. The improved matching works are very heavy and powerful in all parts; the three cylinders are four sided and slotted and furnished with chip breaking lips to work cross-grained or knotty lumber, while the shaving hoods swing outward to give access to the knives. The pressure bars have easy and quick adjustments, and possess many improved points to facilitate their operation.

4. The lower cylinder is vertically adjustable at each end, and the second upper cylinder is at the feeding-out end of the machine, being designed to give a light skimming cut. It revolves at a much higher rate of speed than the other cylinders, and fine smooth work is insured, with all wear compensated by the cylinder-raising screws.

Further details, cuts fully describing it, and terms, will be sent to those interested by the makers, J. A. Fay & Egan Co., of No. 222 to 242 West Front street, Cincinnati, Ohio, who will also send free their new and complete catalogue.

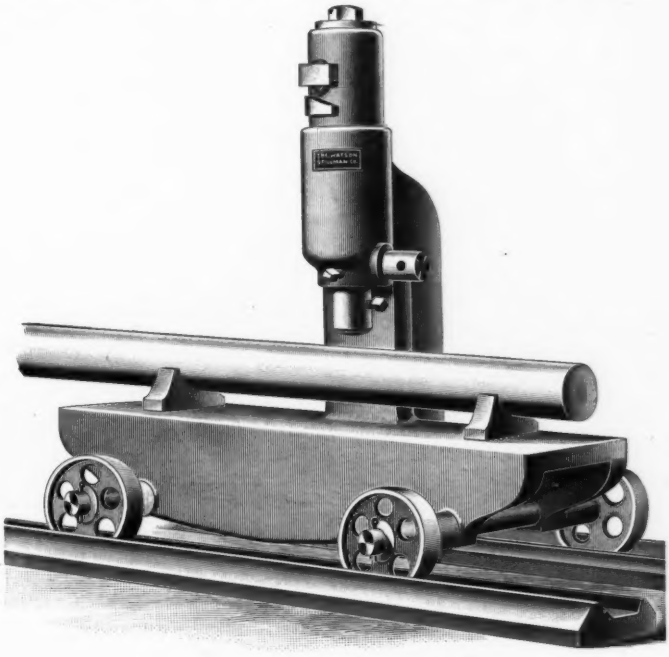
Hydraulic Bending Tool.

THERE are many conditions in machine shop practice where small hydraulic tools are of great value, particularly tools for bending heavy shaft or for forcing bushings in collars, mandrils, etc. The accompanying illustration shows one of the latest of these tools manufactured by the Watson-Stillman Co.

This tool was originally designed for bending 3½-inch shaft, but in actual prac-

tice it has been used as a hydraulic punch, a punch and die being substituted. It has also been used for bending angle and "T" iron, for bushing collars and various other purposes. It is mounted on wheels to fit the ways of a lathe, the wheels being adjustable on the axles to suit the different widths of bed. The method of operation is very similar to the operation of a hydraulic jack, and one man is all that is necessary to place the full pressure of 35 tons upon the work. It is fitted with a raising and lowering device, necessitating but one stroke of the lever to bring the ram down upon the work, when the actual labor is performed by a few strokes of the pump lever which fits in the upper socket shown on the head of the tool. In operating the pump, the power is applied perpendicular to the bed of the lathe, thus eliminating any torsional strains which might prove damaging to the shear of the lathe.

After the bend has been completed the hydraulic pressure is released exactly the same as with a hydraulic jack, and one stroke of the raising lever returns the ram to the cylinder ready for the next operation or for proving the curvature of the work. Short buckles are easily removed from 3½-inch shafting, making the bend cold. All liquids are contained in the upper part or head of the tool, which acts as a reservoir. This liquid is forced into the pressure cylinder by a small bronze pump placed inside of the reservoir. The body is made of steel, the bed of the tool being 25 inches long and 2⅛ inches from the center of the ram to the back of the jaw.



HYDRAULIC BENDING TOOL.

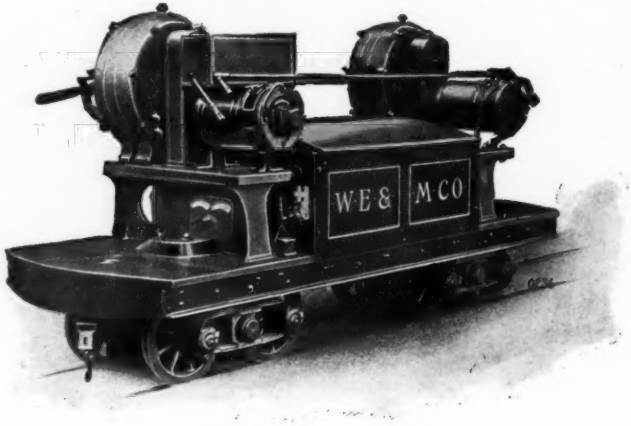
The total height of the tool is 33 inches, bringing the pump lever at a very convenient position for operation. This tool has had quite a ready sale in the machine shops of the United States Navy and is one of the new interesting devices now on the market. Any further information concerning their hydraulic tools will be gladly furnished by the Watson-Stillman Co., 204-210 East 43rd street, New York.

Electric Locomotives for Shop Railways.

AN industrial or narrow-gauge railway has become indispensable for the transportation of material about the yards, buildings and bays of a large manufacturing plant.

If the cars and loads are small, one man, or, at the most, two men can push them from one part of the shop to another. However, if there are grades about the plant or large quantities of heavy material to be moved, recourse must be had to some greater power. The storage-battery electric locomotive is an ideal motive power for this purpose. The photograph of one now in service in the Westinghouse plant gives a very good idea of the form and arrangement of such a locomotive.

The storage battery, motors, controllers and gear cases are above the platform surface, which permits all the vital parts to be



HUNT ELECTRIC LOCOMOTIVE.

inspected or repaired with the utmost ease. The locomotive is carried on two swiveling trucks with every wheel a driver, giving a maximum tractive effort, and enabling it to draw large loads and ascend heavy grades. It runs smoothly around curves of 12-foot radius, so that all parts of the works are accessible.

The energy is furnished by a storage battery which is recharged at night or at intervals during the day when the locomotive is idle. To properly charge the battery requires about one-third the time of operation, although this depends somewhat upon the duty put upon the locomotive; but in any event the daily cost of current for charging is almost insignficant. The battery is divided into sections through the controller, with the motor armatures and fields in various series-parallel combinations. No rheostats or resistances of any kind are on the locomotive, and consequently there is no waste of energy in starting or running. Two Westinghouse vehicle-type motors are mounted, one driving each truck, and these are so exactly proportioned to the normal output of the batteries and the weight of the locomotive that they are not, and can not be overloaded by the motorman. One of these locomotives is capable of hauling about fifty tons on the level, and a corresponding load on grades.

Many advantages of this type of locomotive are at once apparent. It is always ready for use, night and day; an ordinary workman without technical knowledge can operate the locomotive and charge the batteries; the motors are iron clad, the gear cases enclosed in an oil tight case, the battery, controller, etc., are thoroughly protected from injury; no expense is incurred when not in operation; there are no trolley wires or return current with attending fire risk; and the locomotive is wholly self-contained. Two of these electric locomotives were recently furnished to the Westinghouse Electric and Manufacturing Co. and the Westinghouse

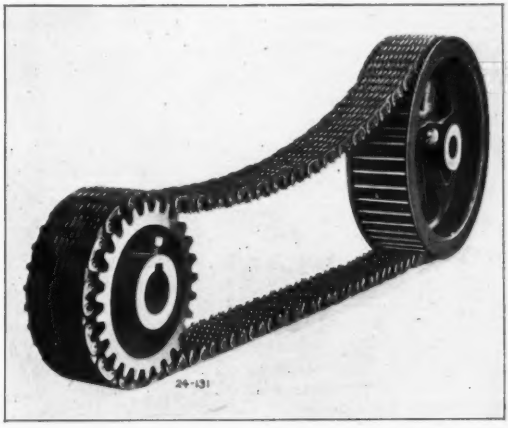
Air-Brake Co. by the C. W. Hunt Company, New York, which last company also supplied the railway and all its equipment, and will be glad to furnish any further information on request.

The Renold Silent Chain.

ALTHOUGH the many advantages inherent in the separate motor system of driving tools are generally recognized, the difficulties encountered in connecting the motors to the tools with any of the older forms of gearing have prevented the system from being as widely adopted as otherwise would have been the case.

With the advent of the Renold Silent Chain, the problem of the transmission of power from motor to machine has been successfully solved. This epoch-making device is peculiarly adapted for this class of service. It can be run on shorter centers than practicable with leather belting and on longer centers than possible with spur gearing. Thus, in contrast with other transmitting devices where the tool and motor must be arranged to suit the nature of the belting or gearing, the Renold Silent Chain adapts itself to any arrangement of the tool and motor which may, in that particular case, be most convenient.

The larger engraving is of a Silent Chain Drive, the chain running at 900 feet per minute, driving a 50-horse-power pump at 225 r. p. m. The smaller cut, on next page, illustrates a 35-horse-power variable-speed motor connected to a rotary pressure blower. Tests have shown that motors connected by Renold Silent Chain take considerably less current to perform their work than when connected by any other medium. In one instance, where the chain has supplanted spur gearing the saving in current is in excess of 15 per cent. Any further information concerning this interesting device will be gladly furnished by the Link-Belt Engineering Co., Nicetown, Philadelphia.



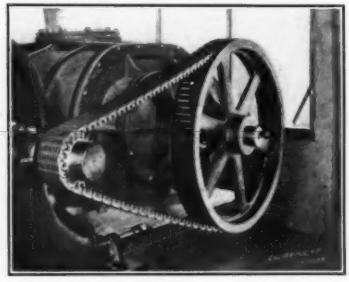
RENOLD SILENT CHAIN.

Electrical Equipment of Mines.

WHEN the mining properties on the Comstock Lode were first developed, operations were carried on by means of steam generated power, wood being used as the fuel. This was very costly on account of the scarcity of wood. The milling was done, until quite recently, at a distance of some 15 miles from the mine, at a point on the Carson River where cheap water power could be obtained. About two years ago the question of electrical transmission for the purpose of supplying power for deep mining operations on the Comstock Lode was taken up and since then, extensive

hydraulic developments have been carried out at Floriston, Cal., on the Truckee River, Power is now transmitted 35 miles to the mines in Stotey County and a dozen or more of the properties have been equipped with electrical machinery. Among these is the C. & C. shaft of the Consolidated California & Virginia Mining Co., which has a world-wide reputation as a bullion producer.

The plant has been in continuous operation since October 20, 1900. The Truckee River General Electric Co. sells power to the various mining companies at $7.00 per horse-power per month, the amount used being based on a maximum peak load of two minutes duration. This, with other conditions, has made advisable the installation of machinery of the very highest grade and the introduction of some features which are rather unique in character. In the C. & C. Shaft at Virginia City every precaution has been taken to secure thorough reliability and the highest efficiency, and there the



RENOLD SILENT CHAIN.

electrical machinery in operation on the surface is the following: A 200-H. P., type "F," 2,200-volt, variable-speed, 3-phase, Westinghouse induction motor, geared to balanced electric hoist; a 100-H. P., type "C," 2,200-volt, Westinghouse induction motor, belted to a 16½ in. x 30 in., single-stage air compressor; a 30-H. P., type "C," 440-volt Westinghouse induction motor, operating circular saws; a 15-H. P. motor of the same type, driving tools in the machine shop; a 10-H. P., type "C," operating a Blake rock breaker at the ore bin; three 15-K. W., indoor type, Westinghouse transformers, transforming from 2,200 volts to 440 volts; one 5-K. W., Westinghouse lighting transformer, transforming from 2,200 volts to 110 volts; two Manhattan arc lamps; fifty incandescent lamps, together with necessary lightning arresters, fuse blocks, cut-outs and switches.

The apparatus underground consists of the following: A 15-H. P., type "C," induction motor, operating at 440 volts and driving a fan on the 250-ft. level; two 10-H. P. motors of the same type, driving fans on the 1,950-ft. and 2,150 ft. levels; three 225-H. P., type "C" motors, operating at 2,200 volts, and geared to three duplex double-acting Riedler pumps located on the 2,150 ft. level; three 10-K. W., type O. D. transformers, transforming from 2,200 to 440 volts, located on the 1,750 ft. level; a 3-K. W. lighting transformer, transforming from 2,200 volts to 110 volts, on the same level; three 15-K. W., type O. D., transformers, transforming to 440 volts, on the 1,950 foot level; two 5-K. W., O. D. lighting transformers, transforming from 2,200 volts to 110 volts, on the same level; three 10-K. W. transformers, transforming to 440 volts, on the same level; a 5-K. W. lighting transformer, transforming to 110 volts, on the same level.

These are all Westinghouse transformers and supply the motor and lighting circuits within the mine.

The compressed-air plant, supplying air for drilling, a number of underground hoists and the hydraulic pump, consists of a 16½ inch x 30 inch Rand & Waring single-stage air compressor, driven at 73 r. p. m. by a 100-H. P., type "C," Westinghouse motor.

This plant is undoubtedly one of the best and most complete mining installations in the world and its operation has been entirely satisfactory both in regard to economy and reliability. Up to the time when electrically transmitted power was adopted, the cost of motive power was never less than $20 per horse-power per month, while under existing conditions, it is reduced to $7.00. For example, the cost of operating the 100-H. P. air compressor usually averaged about $1,800 per month, while to-day it is only $672. The entire plant was installed according to the plans and specifications of Leon M. Hall, consulting engineer, and under the able direction of Sup't Jos. R. Ryan. It has proved an unqualified success from the very beginning.